REVUE SUISSE DE ZOOLOGIE 114 (1): 141-174; mars 2007

Cestodes of the genus *Biuterina* Fuhrmann, 1902 (Cyclophyllidea: Paruterinidae) from passeriform and piciform birds in the Ivory Coast, with a key to the species of the genus

Boyko B. GEORGIEV[1, 2] & Jean MARIAUX[3]
[1] Central Laboratory of General Ecology, Bulgarian Academy of Sciences,
2 Gagarin Street, 1113 Sofia, Bulgaria. E-mail: bbg@ecolab.bas.bg
[2] Department of Zoology, Natural History Museum, Cromwell Road,
London SW7 5BD, UK.
[3] Natural History Museum, P.O. Box 6434, 1211 Geneva 6, Switzerland.
E-mail: jean.mariaux@ville-ge.ch

Cestodes of the genus *Biuterina* Fuhrmann, 1902 (Cyclophyllidea: Paruterinidae) from passeriform and piciform birds in the Ivory Coast, with a key to the species of the genus.- On the basis of recently collected material from the Ivory Coast (République de Côte d'Ivoire) and other specimens from the collections of Geneva Natural History Museum, we review the species of *Biuterina* (Paruterinidae) known from that country. Five species are recorded, among which two are new: *B. pogoniuli* sp. n. from *Pogoniulus scolopaceus* (Piciformes: Capitonidae) and *B. petroniae* sp. n. from *Petronia dentata* (Paseriformes: Ploceidae). *B. africana* Joyeux & Baer, 1928, from *Tchagra* spp. (Passeriformes: Laniidae), is redescribed on the basis of the type material from Benin, as well as of specimens from Angola, Guinea and the Ivory Coast. The species is reported for the first time from the latter two countries. *B. pentamyzos* (Mettrick, 1960) from *Prionops plumata* in Zimbabwe is recognised as a synonym of *B. africana* (new synonymy). *B. cordifera* Murai & Sulgostowska, 1983 and *B. triangula* (Krabbe, 1869) are reported from new hosts (*Acrocephalus arundinaceus* and *Anthus leucophrys gouldii*, respectively) and for the first time in Africa. An identification key to the 34 species of *Biuterina* presently recognized worldwide is given.

Keywords: Parasite - helminths - Paruterinidae - Biuterina - Africa - Ivory Coast - systematics - morphology - Laniidae - Ploceidae - Capitonidae - Sylviidae - Motacillidae.

INTRODUCTION

Biuterina Fuhrmann, 1902 comprises cestode parasites from passeriform and coraciiform birds; the number of the included species is considered to be between 30 and 40 depending on the generic definition adopted or on the views on the species validity (Matevosyan, 1969; Bona & Maffi, 1984; Schmidt, 1986; Kornyushin, 1989;

Manuscript accepted 12.12.2006

Mariaux & Vaucher, 1989; Georgiev & Kornyushin, 1994; Georgiev *et al.*, 2002, 2004). The species diversity of this genus is relatively well studied in temperate latitudes (e.g., Matevosyan, 1969; Kornyushin, 1989; Georgiev *et al.*, 2004). However, most of the tropical *Biuterina* spp. are known from single records only. Five of the six species originally described from Afrotropical birds were recently redescribed (Mariaux & Vaucher, 1989; Georgiev *et al.*, 2002), but data on their geographical distribution and host ranges remained scarce. The only extensive faunistic survey on avian cestode in Africa during the last 20 years was carried out in the Ivory Coast (for summarised data, see Mariaux, 1994); however, some of the paruterinid species remained identified only at the generic level and their detailed taxonomic description required additional studies.

The aim of the present article is to report new data on the morphology and taxonomy of *Biuterina* spp. collected from birds in the Ivory Coast, West Africa. In addition, we provide an identification key to the species of the genus.

MATERIAL AND METHODS

In total, 1,252 birds belonging to 174 species, 104 genera and 39 families were studied in the Ivory Coast by one of the present authors (JM) during 1985-1988 (for more detailed data, see Mariaux, 1994). Birds were captured with mist nets or shot. They were dissected immediately after death. Cestodes were removed from guts and fixed in 5% hot formalin. They were stored in 70% ethanol, stained in alcoholic hydrochloric carmine, dehydrated in ethanol series, cleared in clove oil and mounted in Canada balsam. Some scoleces were mounted in Berlese's medium to facilitate the examination of the rostellar hooks. The specimens were deposited in the Invertebrate Collection of the Natural History Museum, Geneva (MHNG). Details on their collection data and number of specimens are given in the text for each species.

The metrical and meristic data are presented as the range, with the mean in parentheses and the number of measurements or counts taken (n). The measurements are given in micrometres unless otherwise stated. The developmental stages of the proglottides are designated as previously described (Georgiev & Vaucher, 2001). The nomenclature for the birds follows Howard & Moore (1980).

TAXONOMIC PART

Biuterina africana Joyeux & Baer, 1928

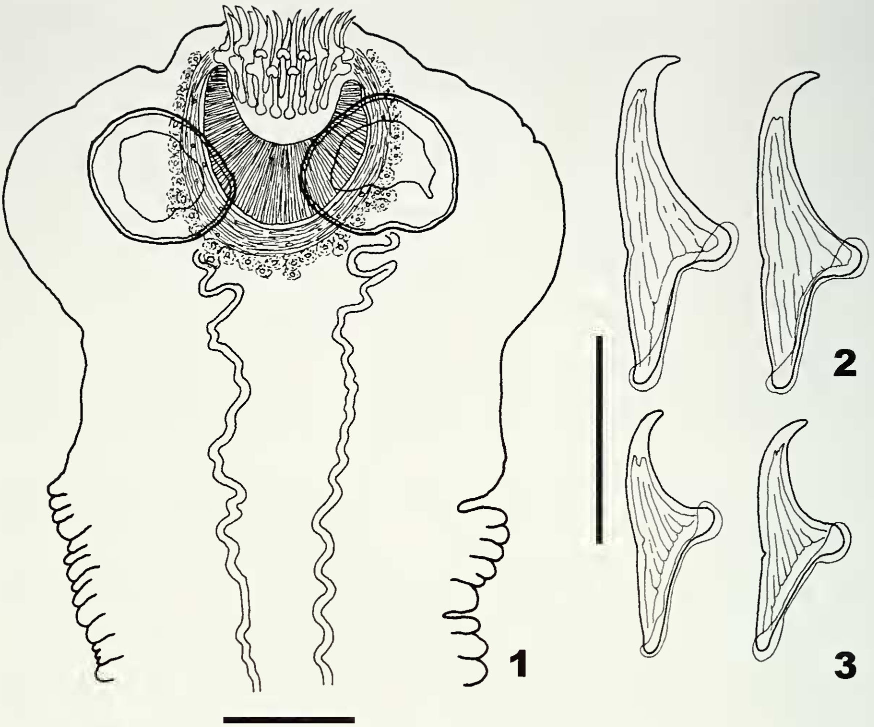
Paruterina pentamyzos Mettrick, 1960, new synonymy
Biuterina pentamyzos (Mettrick, 1960) Matevosyan, 1964

MATERIAL EXAMINED: MHNG INVE 44454-44455 (Collection Joyeux, nos CJ 28/73a and CJ 28/74a), 2 slides, labelled "*Biuterina africana*, *Telephonus senegalus*, Gendre", one of them containing a stained scolex squashed in Canada balsam, and the other containing three stained pregravid specimens in Canada balsam; recognised here as syntypes of *B. africana* (see Remarks); from *Tchagra senegala* (synonyms *Pomatorhynchus senegalus*, *Telephonus senegalus*) (Passeriformes: Laniidae) collected at Bohicon, Benin by E. Gendre (see Joyeux & Baer, 1928); substantial parts of strobila contracted. – MHNG INVE 44456 (Collection Joyeux, nos CJ 28/75a and CJ 28/78), 2 slides, labelled "*Biuterina africana*, *Telephonus senegalus*, Gendre, Labé", containing longitudinal sections of strobilar fragments of mature and postmature proglottides; from *Tchagra senegala* collected at Labé, Guinea by E. Gendre; these specimens were not mentioned in the publications of Joyeux. – MHNG INVE 40301 (Collection Fuhrmann - Baer nos 20/60-63), 4 slides, labelled "*Biuterina africana*, pie grièche, Angola" (two slides) or "*Biuterina africana*, *Pomatorhynchus*, Angola" (2 slides); mentioned by Fuhrmann (1943). Exact host names are not given in the labels; according to Fuhrmann (1943), *B. africana* was recorded in Angola from *Pomatorhynchus australis* (Smith) [now *Tchagra australis* (Smith)], *Pomatorhynchus senegalus* (L.) [now *Tchagra senegala* (L.)] and *Pomatorhynchus anchietae* (Bogage) [now *Tchagra minuta anchietae* (Bocage)] (Passeriformes, Laniidae). – MHNG INVE 16117 (former no 988.414, see Mariaux, 1994), 4 slides (2 fragmented specimens stained in hydrochloric carmine and mounted in Canada balsam and 2 scoleces mounted in Berlese's medium), from *Tchagra senegala pallida* (Neumann) (Passeriformes: Laniidae), collected at Tortyia, Ivory Coast, on 10 February 1987, by J. Mariaux; mentioned by Mariaux (1994). The host specimen has been deposited in the Ornithological Collection of the MHNG, no. 1768.047.

RE-DESCRIPTION OF THE SYNTYPES: Pregravid specimens with band-like body, 11.2-14.2 mm (12.4 mm, n =3) long, consisting of 106-114 (109, n=3) proglottides; contracted, single specimen with relaxed portions of strobila; maximum width at pregravid proglottides, 612-734 (654, n = 3). Scolex wider than neck, laterally rounded, with maximum width at middle of suckers, 385-450 (420, n = 3) (Fig. 1). Suckers oval, 115-130 (121, n = 7) in diameter, with well-developed musculature; in single specimen, inner surface of suckers with punctiform spines (not distinct in remaining specimens). Rostellum sucker-like, retracted in all available specimens, with diameter 125-145 (133, n = 3); vertical muscular fibres inside distinct. Thick layer of radial muscular fibres surround rostellum (Fig. 1); glandular cells surround radial musculature. Rostellar hooks arranged in 2 regular rows; 2 of 4 available scoleces had missing rostellar hooks and others had densely packed hooks, for which exact number is difficult to determine but there are at least 38. Each hook with epiphyseal thickening on both handle and guard. Anterior hooks 75-80 (78, n = 12) long; blade longer than handle (Fig. 2). Posterior hooks 55-60 (58, n = 12) long; blade shorter than handle (Fig. 3). Rostellar hooks with blades directed anteriorly when rostellum is retracted. Genital pores irregularly alternating in short series, e.g. ... 2, 1, 3, 1, 2, 1, 2, 5, 1, 2, 2, 2; pores open about middle of lateral proglottis margin. Genital atrium represented by infundibular distal part with thick walls and tubular proximal part surrounded by aggregation of glandular cells (Fig. 5). Dorsal osmoregulatory canals 5-8 (n = 10) in diameter; ventral osmoregulatory canals with diameter 13-38 (n = 10), with transverse anastomoses along posterior proglottis margin. Genital ducts pass between osmoregulatory canals.

Testes 10-14 (11, n = 15) in number, oval, form compact group in posterior most part of median field, posterior, dorsal and lateral to vitellarium and posterior and lateral to ovary, may overlap posterior margins of ovary dorsally (Fig. 4). External vas deferens coiled, with diameter 5-8 (7, n = 10), forms dense body in anterior poral part of median field together with surrounding glandular cells. Cirrus-sac highly elongate, 193-225 x 27-41 (215 x 33, n = 10), mostly cylindrical, tapered porally and rounded antiporally, thick-walled, usually crosses poral osmoregulatory canals. Internal vas deferens coiled. Evaginated cirrus not observed; minute (>1 μm long) triangular spines present in canal of withdrawn cirrus.

Ovary 110-145 (122, n = 10) wide, symmetrical, consisting of 2 compact rounded wings. Vitellarium compact, oval, 42-60 (52, n = 10) in diameter, at some distance from posterior proglottis margin (Fig. 4). Mehlis' gland indistinct. Seminal receptacle elongate, situated dorsally, mostly between wings of ovary, extends from



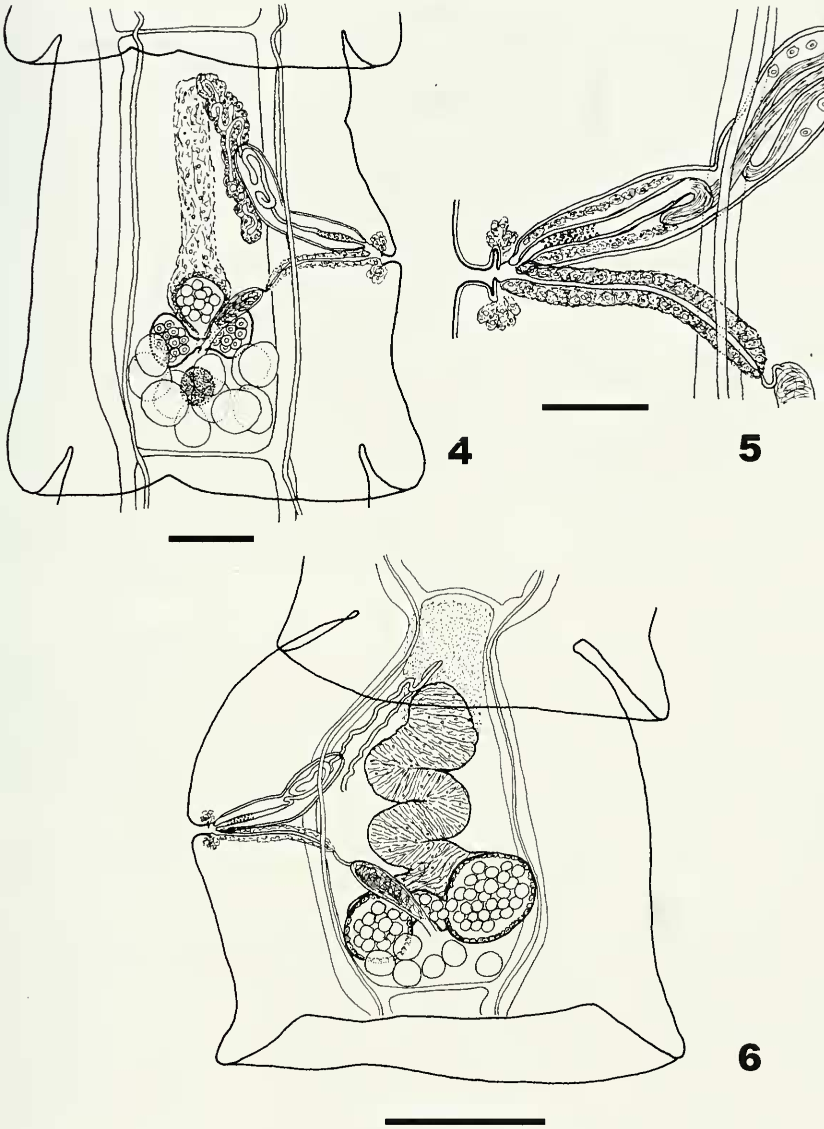
Figs 1-3

Biuterina africana Joyeux & Baer, 1928, syntypes from *Tchagra senegala* in Benin. (1) Scolex. (2) Anterior rostellar hooks. (3) Posterior rostellar hooks. Scale bars: 1, 100 μm; 2, 3, 50 μm.

poral part of median field at level anterior to ovary to level of vitellarium, 105-118 x 28-33 (112 x 30, n = 7). Vagina opens postero-laterally to male pore, with copulatory part 138-180 (169, n = 7) long and 18-23 (20, n = 10) in diameter, consisting of thick-walled vaginal canal and cellular sleeve along entire length, with diameter of lumen 4-7 (6, n = 7), wider at poral end; conductive part of vagina short, narrow.

Uterus in mature proglottides sac-like, spherical or with slightly irregular shape, thick-walled (Fig. 4). Primordium of paruterine organ appears as consolidation of central part of medullary parenchyma anterior to uterus. In pregravid proglottides, uterus consists of 2 sacs connected by transverse isthmus; paruterine organ elongate, may be slightly convoluted, with tapering anterior end surrounded by granular tissue (Fig. 6). No fully-developed eggs in specimens available.

Description of the material from the Ivory Coast: Strobila band-like, gradually widening in posterior direction, with maximum width 751-848 (n = 2) at level of pregravid proglottides. Scolex rounded, wider than neck, with conical anterior protrusion (Fig. 7); maximum width 372-437, at middle of suckers. Suckers oval, 130-161 (144, n = 8) in diameter, with developed musculature; their inner surface provided punctiform spine-like structures in transverse rows (Fig. 7, 12). Rostellum sucker-like,



FIGS 4-6

Biuterina africana Joyeux & Baer, 1928, syntypes from *Tchagra senegala* in Benin. (4) Mature proglottis, dorsal view. (5) Genital ducts in a mature proglottis, dorsal view. (6) Gravid proglottis. Scale bars: 4, 6, 200 μm; 5, 50 μm.

with diameter 148 (n = 1) when retracted and 186 (n = 1) when protruded. Rostellum surrounded by thick layer of radial muscular fibres and intensely staining glandular cells (Fig. 7). Rostellum armed with 38 (n = 3) or 42 (n = 1) rostellar hooks arranged in 2 regular rows. Each hook provided with epiphyseal thickening on both handle and guard. Anterior hooks 82-85 (83, n = 6) long, with length of refractive particle 81-82;

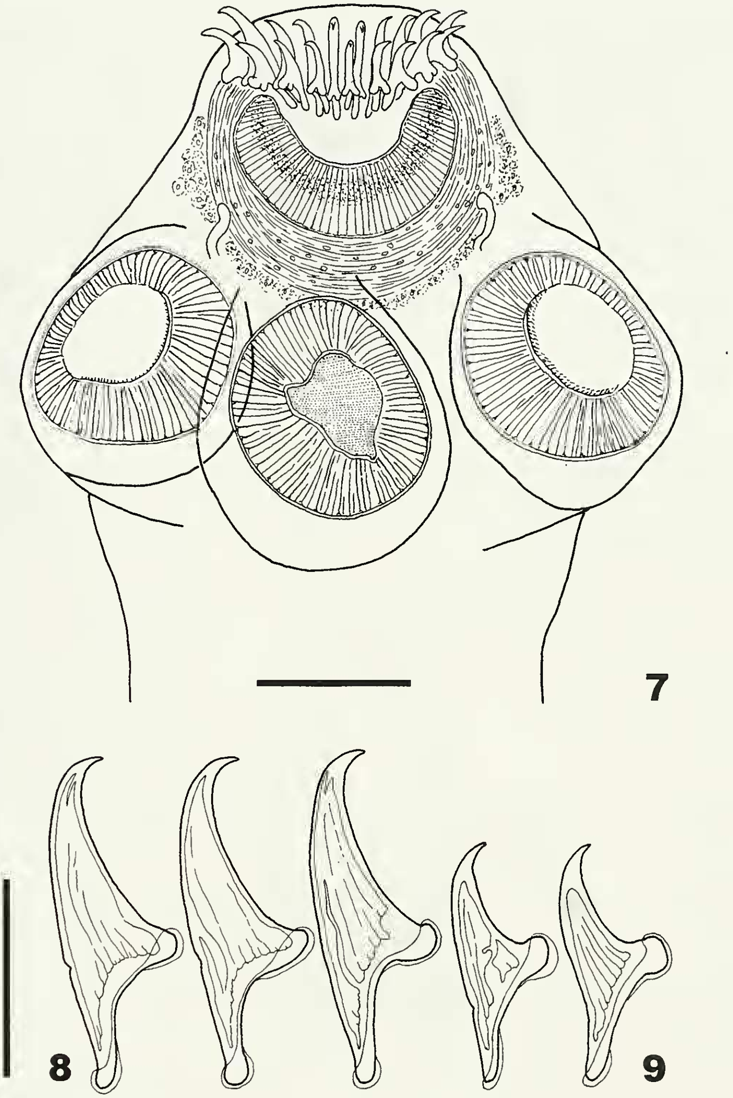
blade longer than handle (Fig. 8). Posterior hooks 61-63 (62, n = 6) long, with length of refractive particle 58-60; blade shorter than handle (Fig. 9). Proglottides craspedote; mature proglottides wider than long (Fig. 10); gravid proglottides slightly longer than wide (Fig. 11). Genital pores irregularly alternating in short series, open about middle of lateral proglottis margin. Genital atrium consists of infundibular thick-walled orifice and tubular hermaphroditic canal surrounded by intensely staining cells. Dorsal osmoregulatory canals 4-8 (n = 10) in diameter. Ventral osmoregulatory canals with diameter 22-47 (n = 10), with transverse anastomoses along posterior margin of each proglottis. Genital ducts between poral osmoregulatory canals.

Testes 10-15 (12, n = 11) in number, oval, situated in compact group posterior, dorsal and lateral to vitellarium and posterior and lateral to ovary, may overlap posterior margins of ovary (Fig. 10). External vas deferens coiled, with diameter 5-12 (7, n = 10), together with surrounding intensely stained cells forming dense body in anterior poral part of median field. Cirrus-sac highly elongate, 171-232 x 30-37 (201 x 34, n = 10), mostly cylindrical, with tapering poral end and rounded antiporal end, thick-walled; in mature proglottides, usually cross poral osmoregulatory canals; in gravid proglottides, often entirely situated in lateral field or slightly crossing poral osmoregulatory canals. Internal vas deferens coiled. Evaginated cirrus not observed; minute (length < 1 μm) triangular spines with pointed tips seen in canal of withdrawn cirrus.

Ovary consisting of 2 compact symmetrical wings. Vitellarium compact, oval, 51-69 (62, n = 10) in diameter, at some distance from posterior proglottis margin (Fig. 10). Mehlis' gland not observed as glandular structure. Seminal receptacle elongate, situated mostly dorsally between wings of ovary, extends from poral part of median field at level anterior to ovary to level of vitellarium. Vagina opens posterolaterally to male orifice, with copulatory part 174-223 (193, n = 7) long, 14-23 (18, n = 10) in diameter, consisting of thick-walled vaginal canal and thick cellular sleeve along entire length; poral part of vaginal canal wider, covered with distinct microtriches; conductive part of vagina short and thin.

Uterus in mature proglottides sac-like, spherical or with irregular shape, thick-walled (Fig. 10). Primordium of paruterine organ appears as consolidation of central part of medullary parenchyma anterior to uterus. In pregravid and gravid proglottides, uterus consists of 2 sacs connected by thin transverse isthmus; paruterine organ elongate, with tapering anterior end surrounded by granular tissue (Fig. 11). Eggs oval; outer envelopes thin, often not distinct. Embryophore oval, thick, with diameter 40-45 (43, n = 10). Oncosphere oval, with diameter 28-34 (31, n = 10). Embryonic hooks: central pairs 19-21 (20, n = 7) long; lateral pairs 16-18 (17, n = 10) long.

REMARKS: *Biuterina africana* Joyeux & Baer, 1928 was described from *Tchagra senegala* (L.) (Passerifomes, Laniidae) at Bohicon, Benin (Joyeux & Baer, 1928). Subsequently, it was recorded from the type host in Angola (Fuhrmann, 1943) and the Ivory Coast (Mariaux, 1994), and also from two other species of *Tchagra* Lesson, *T. minuta* (Hartlaub) and *T. australis*, in Angola (Fuhrmann, 1943). The only information on its morphology is the brief original description (Joyeux & Baer, 1928). We found substantial differences between the material from the Ivory Coast and the original description in relation to the size of the rostellar hooks. Other characters were

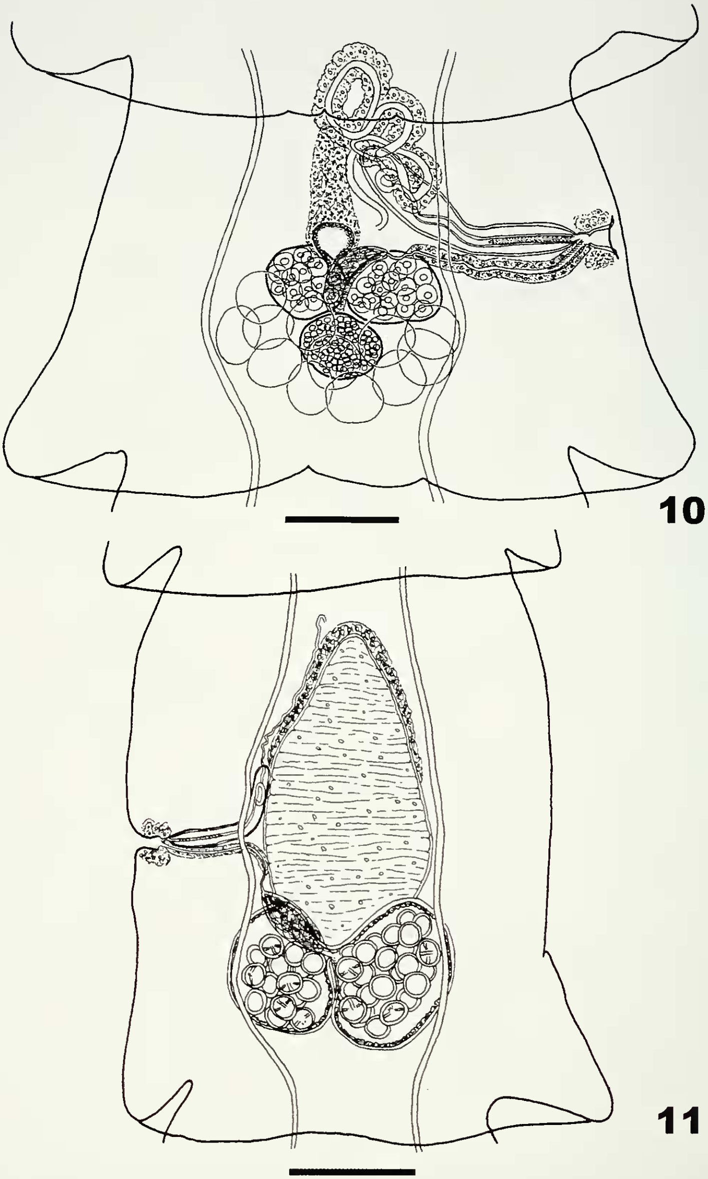


FIGS 7-9

Biuterina africana Joyeux & Baer, 1928, material from the Ivory Coast. (7) Scolex. (8) Anterior rostellar hooks. (9) Posterior rostellar hooks. Scale bars: 7, 100 μm; 8, 9, 50 μm.

difficult to compare because the original description is illustrated with drawings of the scolex and rostellar hooks only; few strobilar characters are described and none of them illustrated. This provoked the present redescription of the type material.

None of the specimens of *B. africana* in the Collection of C. Joyeux (currently deposited in the MHNG) is indicated as type material. We examined 4 slides from the type host «*Telephonus senegalus*» and recognised as syntypes two slides, MHNG



FIGS 10-11
Biuterina africana Joyeux & Baer, 1928, material from the Ivory Coast. (10). Mature proglottis, dorsal view. (11) Gravid proglottis. Scale bars: 10, 100 μm; 11, 200 μm.

44454 and MHNG 44455 (Collection Joyeux nos CJ 28/73a and CJ 28/74a), since their labels are concordant with the information included in the paper containing the original description (Joyeux & Baer, 1928). The other two slides of *B. africana* in Joyeux' collection, MHNG 44456 (Collection Joyeux nos CJ 28/75a and CJ 28/78), contain sectioned strobilar fragments of the same species; however, according to the labels, they were collected at Labé (Guinea) and therefore do not belong to the type series.

Our study revealed discrepancies in the original description in relation to the length of the posterior rostellar hooks and the number of the testes (Table 1). In addition, we found that the most developed specimens of the type series were pregravid; therefore, the original measurements of the body length and the diameter of the eggs are not reliable. The material from the Ivory Coast corresponds well with the morphology of the type series; some differences in the measurements of the rostellum and suckers are probably due to the different state of the material (rather contracted type specimens versus relaxed specimens from the Ivory Coast).

We confirm the identification of Fuhrmann's (1943) material from Angola, although we are not sure of the identity of the host species of the available specimens. Their morphology corresponds well with that of the type series, including to the respective metrical and meristic data (Table 1).

The new morphological data on *B. africana* enables a re-evaluation of the validity of another Afrotropical species of *Biuterina*, *B. pentamyzos* (Mettrick, 1960), a parasite of *Prionops plumata poliocephala* Shaw (Passeriformes, Laniidae) in Zimbabwe (Mettrick, 1960). Its type material was recently redescribed (Georgiev *et al.*, 2002). The morphology of the scolex and both mature and uterine proglottides of *B. pentamyzos* entirely corresponds to the present redescription of *B. africana*, including the metrical data (Table 1). The difference in the body dimensions is due to taking measurements from a fully-developed (gravid) and well-relaxed specimen from the type series of *B. pentamyzos* (see Georgiev *et al.*, 2002) compared with the rather contracted and not fully-developed syntypes of *B. africana*. Therefore, we recognise *B. pentamyzos* as a junior synonym of *B. africana*.

Georgiev *et al.* (2002) reported the presence of an armature on the inner surface of the suckers of *B. pentamyzos* consisting of "fine, punctiform, spine-like structures in transverse rows". This is distinct in the material from the Ivory Coast (Fig. 12). However, it is hardly seen in one of the syntypes of *B. africana* and not distinct in the remaining specimens, probably because of the contracted condition of the scoleces resulting in a highly folded internal surface of suckers.

Matevosyan (1969) mentioned Tunisia as the only locality for *B. africana*. However, we did not find any published record of the species from that country. Summarising the above data, the geographical range of *B. africana* includes Guinea, the Ivory Coast, Benin (type locality), Angola and Zimbabwe; its hosts are restricted to birds of the family Laniidae: *Tchagra senegala* (type host), *T. australis*, *T. minuta* and *Prionops plumata*.

Biuterina cordifera Murai & Sulgostowska, 1983

MATERIAL EXAMINED: MHNG INVE 15927 (formerly no. 987.273, see Mariaux, 1994), 1 slide (fragments of 2 specimens), 14 January 1987, host collection number CI 440 and MHNG INVE 15928 (formerly no. 987.274, see Mariaux, 1994), 1 slide (fragments of 2 specimens), 15 January 1987, host collection number CI 447, from *Acrocephalus arundinaceus* (L.) (Passeriformes, Sylviidae), collected at Adiopodoumé. One of the host specimens (CI 447) has been deposited in the Ornithological Collection of the MHNG, no. 1769.041.

DESCRIPTION: Strobila gradually widening posteriorly; maximum width at level of gravid proglottides 559-578 (n = 2). Scolex (Fig. 13) rounded, with maximum width

TABLE 1. Comparison of some metrical and meristic data for *Biuterina africana* Joyeux & Baer, 1928 and its synonym *B. pentamyzos* (Mettrick, 1960).

Species	*B. africana*	*B. africana*	*B. africana*	*B. africana*	*B. pentamyzos*	*B. pentamyzos*
Host	*Tchagra senegala*	*Tchagra senegala*	*Tchagra* spp.	*Tchagra senegala*	*Prionops plumata*	*Prionops plumata*
Locality	Benin	Benin	Angola	Ivory Coast	Zimbabwe	Zimbabwe
Source	Joyeux & Baer (1928)	Present study	Present study	Present study	Mettrick (1960)	Georgiev *et al.* (2002)
Body: length (mm)	15	11.2-14.2[1]	> 31	-	58[5]	55[5]
Body: maximum width	750	612-734[1]	1,120-1,140	751-848	1,300	1,273
Scolex: diameter	500 x 300	385-450	460	372-437	447	465
Suckers: diameter	190 x 140	115-130	133-145	130-161	133-142	134-157
Rostellum: diameter	200	125-145	145	148-186	182	160
Rostellar hooks: number	44	> 38	40	38-42	42	42
Rostellar hooks, length:						
anterior	84	75-80	80-82	82-85	80-82[3]	84-85
posterior	40	55-60	59-61	61-63	80-82[3]	60-61
Testes: number	5-8	10-14	10-13	10-15	8-10	11-14
Cirrus-sac:						
length	190-250	193-225	163-190	171-232	196	180-227
width	50	27-41	32-40	30-37	26	28-36
Vagina, copulatory part:						
length	-	138-180	162-180	174-223	-	198-247
width	-	18-23	13-22	14-23	-	13-21
Eggs: diameter	25[2]	-		-	35-39	-
Embryophore: diameter	-	-	36-42	40-45	-	41-49
Oncosphere: diameter	-	-	26-32	28-34	-	26-34
Embryonic hooks, length:						
central pair	-	-	20-21	19-21	10-11[4]	19-21
lateral pairs	-	-	17-19	16-18	10-11[4]	16-18

[1] Pregravid specimens; entire strobila or substantial parts of them contracted.

[2] Data on the diameter of eggs do not seem reliable because the type material lacks proglottides with fully-developed eggs.

[3] Lengths of anterior and posterior hooks not given separately.

[4] Lengths of central and lateral embryonic hooks not given separately.

[5] Well-relaxed specimen.

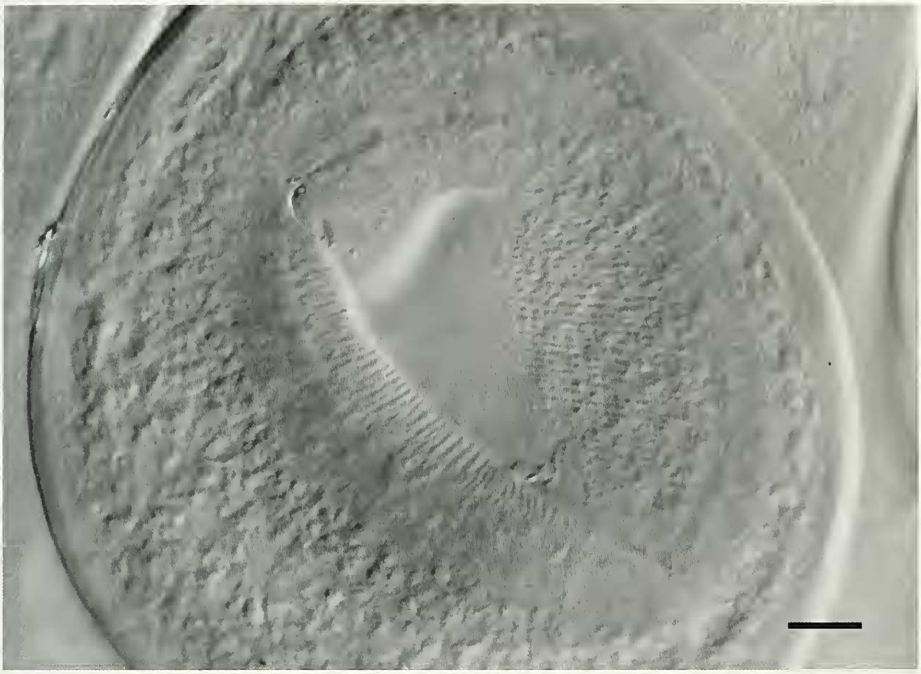
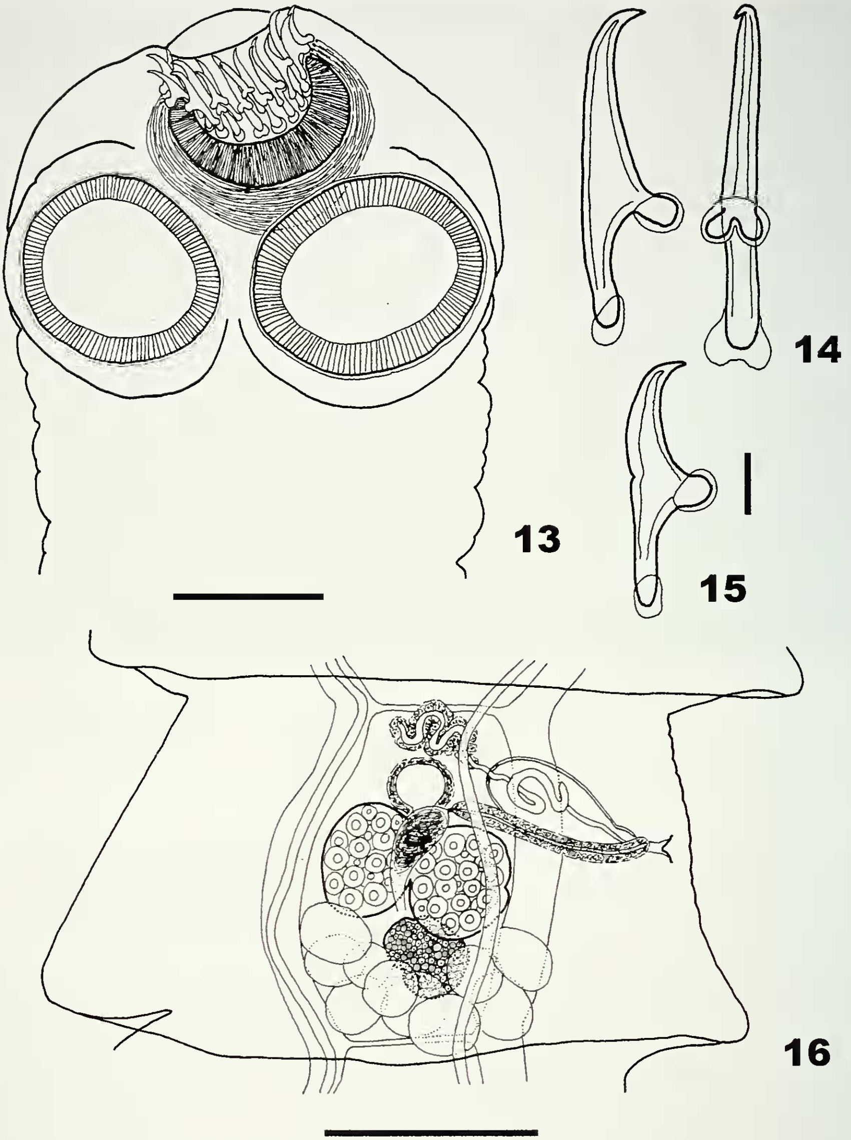


FIG. 12

Biuterina africana Joyeux & Baer, 1928, material from the Ivory Coast. Sucker. Note armament consisting of punctiform spine-like structures arranged in transverse rows on the internal surface of the sucker. Scale bar: 10 µm.

at level of middle of suckers 321 (n = 1). Suckers slightly oval, with well-developed musculature, with diameter 129-150 (142, n = 4). Rostellum of only available scolex retracted (Fig. 13), with diameter 123, sucker-like, highly muscular; no glandular cells visible within or around rostellum. Rostellar hooks 30 in number, arranged in 2 regular rows; their blades directed anteriorly when rostellum retracted; each hook provided with 2 epiphyseal thickenings, 1 on handle and 1 on guard. Anterior hooks 58-62 (61, n = 5) long, with blade considerably longer than handle (Fig. 14). Posterior rostellar hooks 42-45 (44, n = 4), with blade almost as long as handle (Fig. 15). Neck contracted, 207 wide; first proglottides appear at 339 from posterior margin of suckers. Proglottides craspedote (Figs 16-18); mature, postmature and pregravid proglottides wider than long; gravid proglottides as long as wide or slightly longer than wide (Fig. 18). Genital pores irregularly alternating in short series. Genital atrium infundibular, thin-walled; no surrounding intensely stained cells. Genital ducts pass between osmoregulatory canals. Dorsal osmoregulatory canals 4-7 (n = 10) in diameter. Ventral osmoregulatory canals 24-34 (n = 10) in diameter, with transverse anastomoses along posterior margin of each proglottis.

Testes oval, 8-11 (9, n = 10) in number, form compact group situated laterally, dorsally and posteriorly to vitellarium, often overlap posterior margin of ovary and



Figs 13-16

Biuterina cordifera Murai & Sulgostowska, 1983. (13) Scolex. (14) Anterior rostellar hooks. (15) Posterior rostellar hook. (16) Mature proglottis, dorsal view. Scale bars: 13, 16, 100 μm; 14, 15, 10 μm.

ventral osmoregulatory canals (Fig. 16). External vas deferens convoluted, surrounded by intensely stained cells but not forming dense body. Cirrus-sac oval (Fig. 16), 57-84 x 27-33 (70 x 30, n = 10), tapered porally and rounded antiporally, thin-walled, may reach or just cross poral osmoregulatory canals. Internal vas deferens forms several coils in antiporal part of cirrus sac. Evaginated cirrus not observed; no armament within duct of withdrawn cirrus.

Ovary bi-winged, medial, symmetrical, occupies entire width of median field (Fig. 16); wings round, compact. Vitellarium compact or slightly lobed, oval or irregular in shape, with diameter 39-72 (48, n = 10). Seminal receptacle ovoid to elliptical, dorsal to ovary. Vagina opens dorsally to male pore; not clearly separated into copulatory and conductive parts.

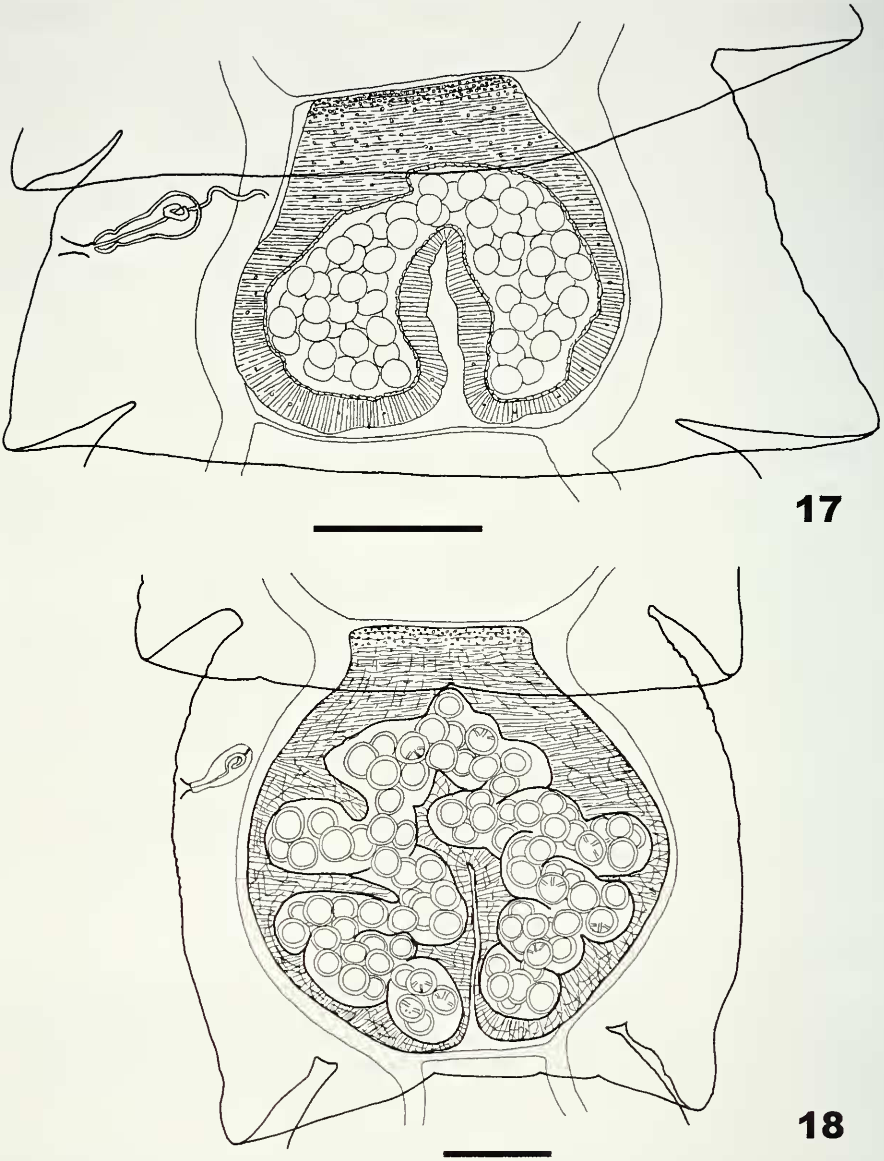
Uterus in mature proglottides antero-dorsal to ovary, sac-like, thick-walled, almost spherical or with irregular shape (Fig. 16). In postmature proglottides, uterus horseshoe-shaped, with lateral ends directed posteriorly; primordium of paruterine organ as consolidation of medullary parenchyma, entirely enveloping uterus. In pregravid (Fig. 17) and gravid (Fig. 18) proglottides, uterus with elongate lateral branches; paruterine organ occupies entire median field; anterior part of paruterine organ granular. In slightly contracted gravid proglottides, uterine branches convoluted, suggesting presence of uterine capsules each containing several eggs (Fig. 18). Eggs oval; outer shell thin, often not distinct, closely envelops embryophore. Embryophore oval, 30-38 (34, n = 10) in diameter, thick-walled. Oncosphere oval, 20-25 (23, n = 10) in diameter. Embryonic hooks: central pair thin, 16-17 (n = 7) long; intra-lateral hooks thin, 14-15 (n = 7) long; extra-lateral hooks stout, 14-15 (n=7) long.

REMARKS: The present material was reported as *Paruterina* sp. from two of nine examined specimens of the host species (Mariaux, 1994). Its morphology fits well with the previous descriptions of *B. cordifera* (see Murai & Sulgostowska, 1983; Georgiev *et al.*, 2004). This species was originally described from *Lusciniola melanopogon* (Temmink) (type host), *Acrocephalus scirpaceus* Hermann and *A. shoenobaenus* (L.) in Hungary (Murai & Sulgostowska, 1983) and later reported from *A. scirpaceus* in the Czech Republic and from *Erithacus megarhynchos* (L.) in Bulgaria (Georgiev *et al.*, 2004). The present study reports the first record of this species in *A. arundinaceus* and the first record for Africa.

Biuterina triangula (Krabbe, 1869) Fuhrmann, 1908

MATERIAL EXAMINED: MHNG INVE 15961 (formerly no. 988.401, see Mariaux, 1994), 5 slides: 1 stained entire pregravid specimen, 5 stained juvenile specimens and 4 stained strobilar fragments without scoleces, and 3 scoleces in Berlese's medium; 11 February 1988, host collection number CI 1051, ex *Anthus leucophrys gouldii* Fraser (Passeriformes, Motacillidae), collected at Tortyia. The host specimen has been deposited in the Ornithological Collection of the MHNG, no. 1765.070.

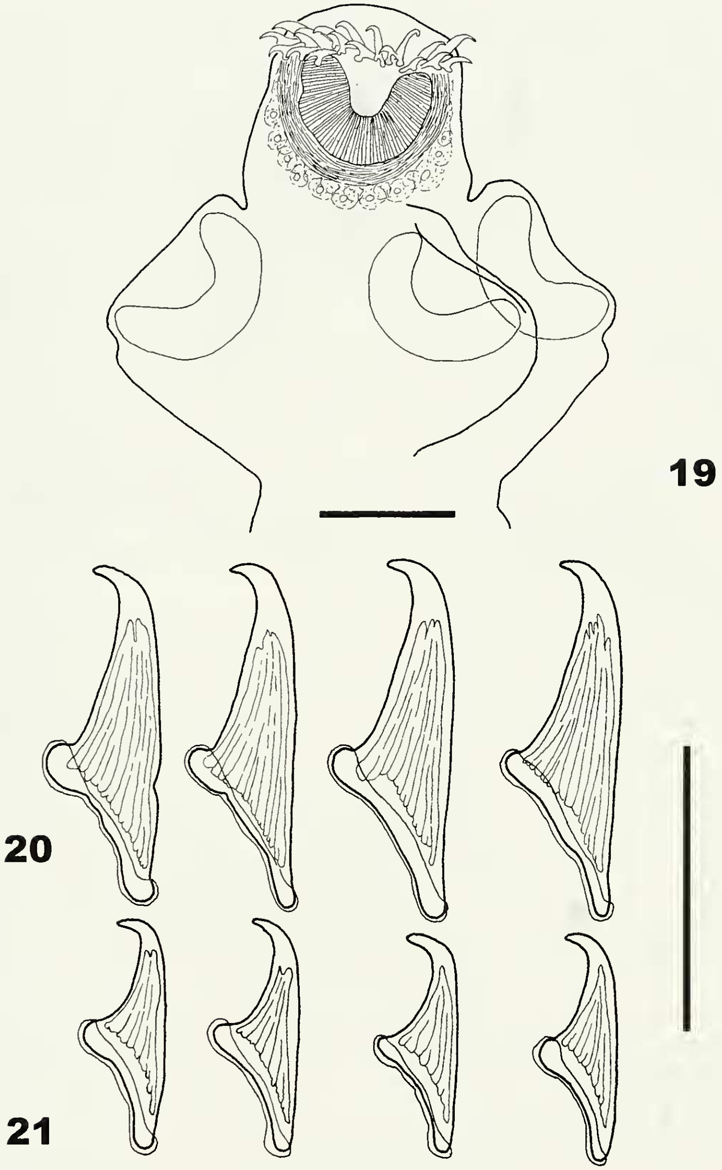
DESCRIPTION: Pregravid specimen 18.5 mm long, with strobila gradually widening posteriorly and reaching maximum width of 770 (n = 1) at level of pregravid proglottides, consists of 107 proglottides: 24 juvenile, 33 premature, 21 mature, 18 postmature and 11 pregravid. Scolex with protruded apical part (Fig. 19), clearly outlined from neck by its greater diameter, with maximum width 350-405 (381, n = 6) at level of suckers. Suckers somewhat oval, with well-developed musculature, 100-140 (121, n = 24) in diameter, with their apertures directed antero-laterally. Rostellum sucker-like (Fig. 19), 102-110 (106, n = 6) in diameter, highly muscular; numerous intensely-staining cells present in anterior half of rostellum. Rostellum separated from



Figs 17-18

Biuterina cordifera Murai & Sulgostowska, 1983. (17) Pregravid proglottis. (18) Gravid proglottis. Scale bars: 100 μm.

surrounding parenchyma by thick layer of radial musculature, outside of which is aggregation of intensely-staining (glandular) cells. Rostellar hooks 40-44 (n = 9) in number (40, n = 3; 42, n = 2; 44, n = 4), arranged in 2 regular rows; blades directed anteriorly when rostellum retracted. Each hook provided with slightly expressed



Figs 19-21

Biuterina triangula (Krabbe, 1869). (19) Scolex. (20) Anterior rostellar hooks. (21) Posterior rostellar hooks. Scale bars: 19, 100 mm; 20, 21, 50 mm.

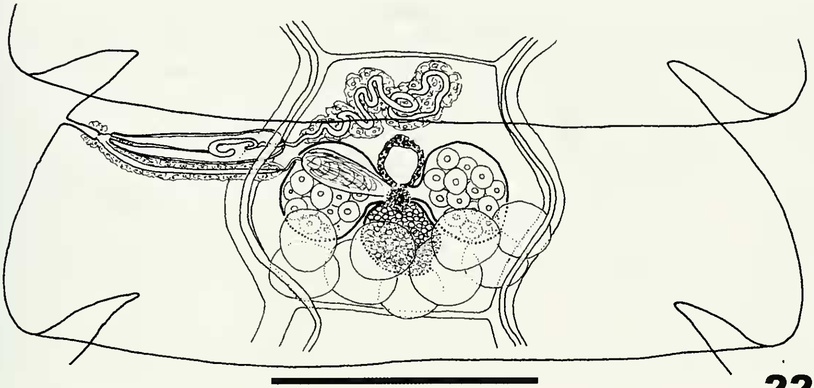
epiphyseal thickening on both handle and guard. Anterior hooks 58-65 (62, n =24) long, with blade considerably longer than handle (Fig. 20). Posterior rostellar hooks 37-43 (41, n =23), with blade almost as long as handle (Fig. 21). Neck 160-202 (180, n = 6) wide in its narrowest part; first proglottides appear at 540-800 (620, n = 6) from posterior margin of suckers. Proglottides craspedote (Figs 22, 24); mature and postmature wider than long; pregravid as long as wide. Genital pores irregularly alternating in short series, e.g. ... 3, 3, 2, 1, 1, 1, 1, 2,1, 2, 1, 3, 1, 1... No genital papilla. Genital atrium thick-walled, 22-27 (24, n = 10) deep, with infundibular aperture, 10-19 (14, n = 10) in diameter, and cylindrical proximal part; intensely staining cells surround genital atrium. Genital ducts pass between osmoregulatory canals. Dorsal osmoregulatory canals 5-12 (n = 10) in diameter. Ventral osmoregulatory canals 18-52 (n = 10) in diameter, with transverse anastomoses along posterior margin of each proglottis.

Testes oval, 6-9 (8, n = 14) in number, form compact group situated laterally, dorsally and posteriorly to vitellarium, overlapping osmoregulatory canals and posterior margin of ovary (Fig. 22); maximum diameter of fully-developed testes 48-58 (54, n = 10). External vas deferens convoluted, surrounded by intensely stained cells, which form dense body at anterior proglottis margin. Cirrus-sac elongate-oval (Fig. 23), with almost cylindrical poral part, thick-walled, reaches or just crosses poral osmoregulatory canals, 135-155 x 24-33 (145 x 29, n = 9) in mature proglottides, 133-155 x 30-33 (142 x 32, n = 4) in postmature and pregravid proglottides. Internal vas deferens forms several coils in antiporal part of cirrus sac. Evaginated cirrus not observed; armament within ductus cirri consisting of small triangular spines (< 1 mm long) which occupy only its distal part (Fig. 23).

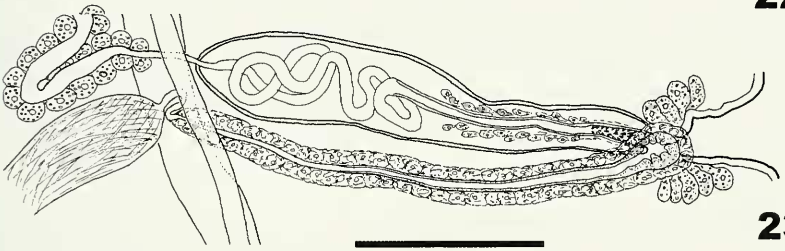
Ovary bi-winged, medial, symmetrical, occupies almost entire width of median field, when fully developed 147-162 (155, n = 6) wide, with round or slightly oval, compact wings (Fig. 22). Vitellarium compact, oval or with irregular shape close to oval, with diameter 45-68 (43, n = 7). Seminal receptacle elongate, almost tubular, with slightly expanded and rounded poral end 22-30 (26, n = 8) in diameter, tapers antiporally and gradually forms straight canal passing towards Mehlis' gland. Mehlis' gland situated anterior to vitellarium, globular, with diameter 23-35 (31, n = 8), not distinct in some proglottides. Vagina opens dorsally to male pore; its copulatory part 113-128 (125, n = 8) long, slightly shorter than cirrus sac or of same length, consisting of thin-walled canal with diameter of lumen 4-6 (n = 8), surrounded by cellular sleeve (Fig. 23); diameter of copulatory vagina 13-18 (15, n = 8). Conductive part of vagina thin, short.

Uterus in mature proglottides antero-dorsal to ovary, sac-like, thick-walled, almost spherical or with irregular shape (Fig. 22). In postmature proglottides, uterus gradually divides into 2 lateral expanded sacs connected by narrow anterior isthmus; primordium of paruterine organ forms as consolidation of medullary parenchyma anterior to developing uterus. In pregravid proglottides (Fig. 24), uterus situated in posterior third of median field, consisting of 2 lateral round sacs; paruterine organ cylindrical, with rounded anterior end surrounded by granular tissue. No developed eggs in material studied.

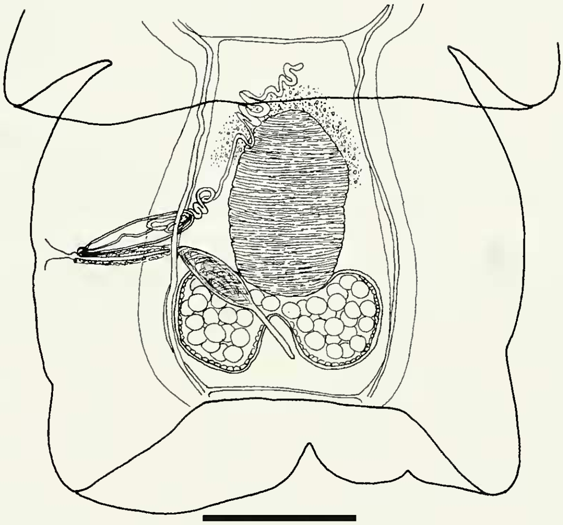
REMARKS: The original description of *Biuterina triangula* (= *Taenia triangulus* Krabbe, 1869) was based on specimens from '*Turdus* sp.' and did not mention the type locality (Krabbe, 1869). The subsequent revisers considered that the material originated from 'West Europe' (Matevosyan, 1969) or 'Central Europe' (Kornyushin, 1989), probably because the collector was Bremser (the naturalist J. G. Bremser of Vienna,



22



23



24

Figs 22-24

Biuterina triangula (Krabbe, 1869). (22) Mature proglottis, dorsal view. (23) Genital ducts in postmature proglottis, dorsal view. (24) Pregravid proglottis, dorsal view. Scale bars: 22, 24, 200 mm; 23, 50 mm.

see Sattman, 2000). As demonstrated by previous studies (Kornyushin, 1989; Georgiev *et al.*, 2004), two other species with anterior rostellar hook of a similar length but with different strobilar morphology, *B. cordifera* and *Spasskyterina trianguloides*

Kornyushin, 1989, were sometimes misidentified as *B. triangula*. Therefore, the data for the host range and the geographical distribution of *B. triangula* need to be re-evaluated, which is difficult for the moment because of the lack of morphological information accompanying most of previous records.

The original description of *B. triangula* is very brief, giving information on the number and the length of rostellar hooks (Table 2) and the irregular alternation of the genital pores (Krabbe, 1869). Fuhrmann (1908) re-examined the type material and additional material from *Turdus pilaris* L. and reported the length of the rostellar hooks of the type as 57 and 39 μm. He mentioned that the types are in bad condition and only added the length of the cirrus sac (0.1 mm) to the original description. Kornyushin (1989) published a detailed redescription on the basis of specimens from *Anthus campestris* (L.) from the Crimea, Ukraine, very much resembling the present material. Some differences in the metrical data (Table 2) are of minor importance and are probably due to the different methods of fixing and processing the specimens.

All the previous records of *B. triangula* are from the Palaearctic Region (Matevosyan, 1969; Kornyushin, 1989). The present finding is the first record of this species in Africa and a new host record.

Biuterina pogoniuli sp. n.

MATERIAL EXAMINED: MHNG INVE 16064, 49753 (formerly no 988.174, see Mariaux, 1994), 3 slides, 1 entire specimen, 1 specimen with scolex mounted separately in Berlese's medium and strobilar fragments of 2 further specimens, from *Pogoniulus scolopaceus* (Bonaparte) (Piciformes: Capitonidae), collected on 20 April 1988 at Dabou. The host specimen has been deposited in the Ornithological Collection of the MHNG, no. 1765.018.

Holotype: MHNG INVE 16064, an entire specimen in Canada balsam, mounted in the same slide with another strobilar fragment.

Paratypes: MHNG INVE 49753, 1 specimen with scolex mounted separately in Berlese's medium and 2 strobilar fragments, 1 of them on the same slide as the holotype.

ETYMOLOGY: The species name *pogoniuli* is a derivate of the generic name of the host.

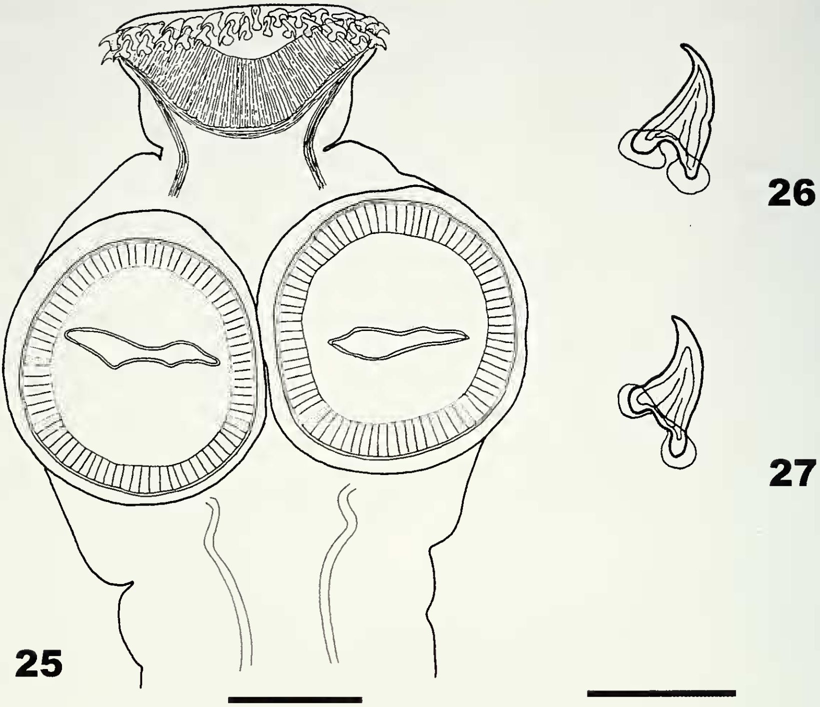
DESCRIPTION: Body band-like. Entire gravid specimen with scolex 37 mm long, consisting of 145 proglottides (44 juvenile, 24 premature, 23 mature, 19 postmature, 26 pregravid and 9 gravid). Specimen without scolex and initial part of strobila, 38 mm long, consisting of 107 proglottides (7 juvenile, 27 premature, 19 mature, 12 post-mature, 33 pregravid and 9 gravid). Maximum width 0.95-1.20 mm (1.05 mm, n = 4), at level of gravid proglottides. Scolex (Fig. 25) almost globular, with maximum diameter 420 (n = 1) at level of middle of suckers; anterior part of scolex protrusible. Suckers round, 179-192 x 179-183 (188 x 180, n = 4) in diameter, with moderately developed musculature, open via transverse slit-like aperture. Rostellum sucker-like, with concave anterior surface, 192 (n = 1) in diameter; numerous vertical muscular fibres and few glandular cells present within rostellum. Layer of radial musculature separates rostellum from surrounding parenchyma. No glandular tissue observed around rostellum. Retractor muscular bundles attached at periphery of rostellum. Rostellar armament consists of 56-62 (n = 2) rostellar hooks arranged in 2 regular rows. Each hook triangular, with epiphyseal thickening on both handle and guard; blades curved. Anterior and posterior hooks of different shape, also differ slightly in

TABLE 2. Comparison of some metrical and meristic data for *Biuterina triangula* (Krabbe, 1869).

Host	*Turdus* sp.	"*Turdus* sp." *Turdus pilaris*	*Anthus campestris*	*Anthus leucophrys*
Locality	Unknown	Unknown	Crimea, Ukraine	Ivory Coast
Source	Krabbe (1869)	Fuhrmann (1908)	Kornyushin (1989)	Present study
Body: length (mm)	-	~30	15-20	18.5[2]
Body: maximum width	-	~1000	450-470	770
Scolex: diameter	-	-	320-450	350-405
Suckers: diameter	-	-	120-170	100-140
Rostellum: diameter	-	-	110-160	102-110
Rostellar hooks: number	32	-	40	40-44
Rostellar hooks, length:				
anterior	55	57	60	58-65
posterior	38-41	39	40	37-43
Testes: number	-	-	8-10	6-9
Cirrus-sac:				
length	-	100	120	135-155
width	-	-	30-40	30-33
Vagina, copulatory part:				
length	-	-	-	113-128
width	-	-	-	13-18
Embryophore: diameter	-	-	27-35	-
Oncosphere: diameter	-	-	20-25	-
Embryonic hooks, length:				
central pair	-	-	17[1]	-
lateral pairs	-	-	17[1]	-

[1] Lengths of the central and lateral embryonic hooks not given separately.
[2] Pregravid specimen.

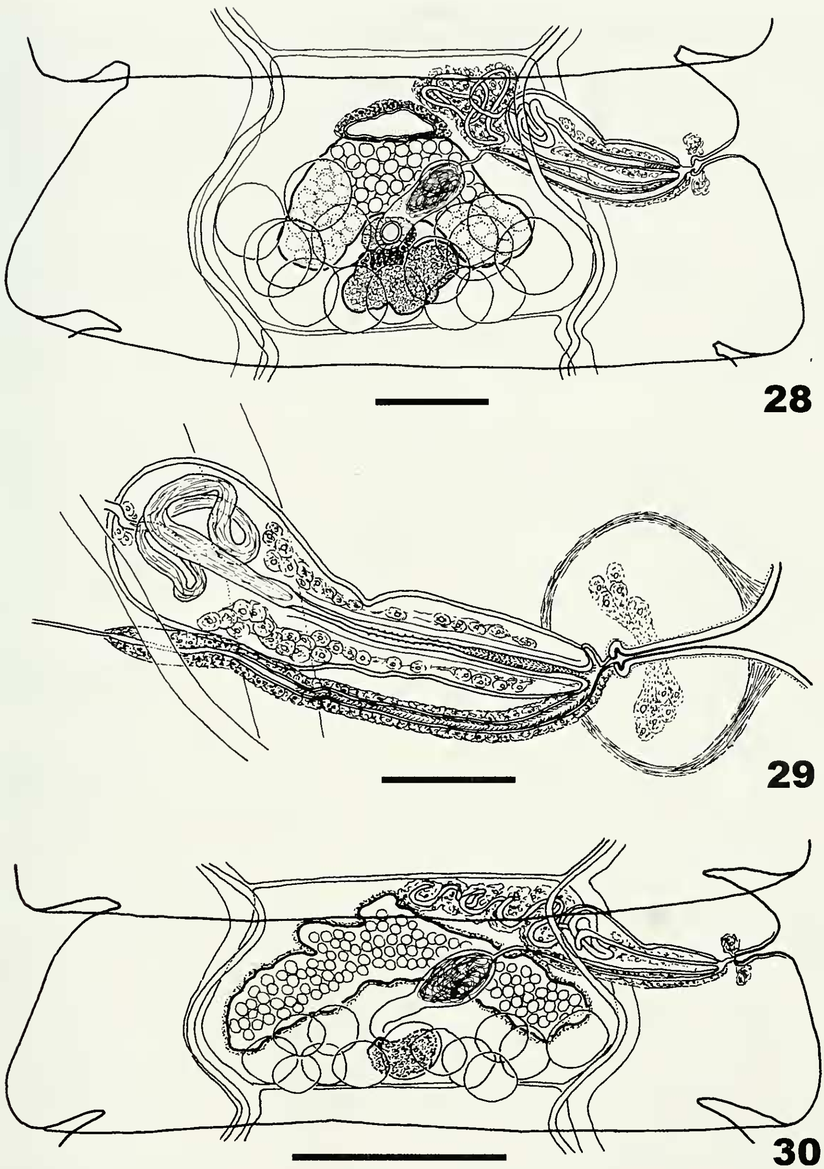
size. Anterior hooks 24-25 (24.5, n = 6) long; blade considerably longer than handle (Fig. 26). Posterior hooks 22-25 (23, n = 4) long; blade slightly longer than handle (Fig. 27). Neck 224 (n=1) wide, long; first proglottides appear at 860 from posterior end of suckers. Proglottides craspedote; juvenile, premature, mature (Fig. 28) and postmature (Fig. 30) and early pregravid proglottides (Fig. 31) wider than long; pregravid proglottides with more advanced development and gravid proglottides (Fig. 33) almost as long as wide or slightly longer than wide. Genital pores alternating irregularly, predominantly in short series but long unilateral series may also occur, e.g., ... 3, 1, 3, 1, 1, 2, 1, 1, 1, 1, 1, 3, 2, 2, 1, 1, 3, 1, 1, 2 or ...9, 1, 1, 1, 1, 1, 10, 2 ... 7, 1, 1, 1, 1, 1, 1, 1, 2, 1, 2, 2, 1, 2, 7...; pores open at junction of anterior and second thirds of lateral proglottis margin in mature and postmature proglottides and slightly anterior to middle of lateral proglottis margin in gravid proglottides. Genital atrium 41-70 (54, n = 10) deep, thick-walled, cylindrical, slightly expanded at its base (Fig. 29), with infundibular aperture 36-66 (52, n = 10) in diameter, provided with aggregation of intensely staining cells. Atrial region might be surrounded by muscular bundles (sometimes not distinct), thus assuming spherical appearance; contraction of these bundles results in formation of short but well-expressed genital papilla. Dorsal osmoregulatory canals 5-9 (n = 10) in diameter, without transverse anastomoses. Ventral osmoregulatory canals 17-40 (n = 10) in diameter, with transverse anastomoses along posterior margin of each proglottis. Genital ducts pass between poral osmoregulatory canals.



FIGS 25-27
Biuterina pogoniuli sp. n. (25) Scolex. (26) Anterior rostellar hooks. (27) Posterior rostellar hook. Scale bars: 25, 100 μm; 26, 27, 25 μm.

Testes 12-17 (14, n = 15) in number, round or slightly oval, form compact group occupying whole width of posterior half of median field, laterally and postero-dorsally to ovary and dorsally and laterally to vitellarium, reach posterior proglottis margin; when fully developed, testes with diameter 68-84 (76, n = 10). External vas deferens convoluted in anterior poral part of median field, surrounded by prostate cells and forming together with them compact transversely-elongate body just adjacent to anterior proglottis margin; diameter of external vas deference 4-7 (5, n = 10). Cirrus-sac oblique, elongate, thick-walled, 165-192 x 49-63 (179 x 55, n = 15), with tapered poral end and widely rounded antiporal end, overlapping or just crossing poral osmoregulatory canals (Figs 28-30). Internal vas deferens convoluted in antiporal part of cirrus-sac, with diameter 8-13 (11, n = 10); intensely staining cells surround withdrawn cirrus. Partly evaginated cirrus cylindrical, 44-66 (n = 2) long, 14-15 (n = 2) in diameter; cirral armament (distinct in both evaginated cirrus and in canal of withdrawn organ) consisting of triangular spines 2-3 μm in length.

Ovary arcuate, with ends directed postero-laterally (Fig. 28), compact or slightly lobate, 179-268 (230, n = 10) wide. Vitellarium with irregular shape, compact, width 98-150 (119, n = 10). Seminal receptacle oval, situated dorsally to ovary and uterus; with rounded poral end; antiporal end gradually forms wide seminal duct.



FIGS 28-30

Biuterina pogoniuli sp. n. (28) Mature proglottis, dorsal view. (29) Genital ducts in postmature proglottis, dorsal view. (30) Early postmature proglottis, dorsal view. Scale bars: 28, 100 μm; 29, 50 μm; 30, 250 μm.

Vagina opens postero-dorsally to male pore; copulatory part almost as long as cirrus-sac, covered with thick cellular sleeve; vaginal canal thick-walled, with its distal part lined with long microtriches and conductive part long, thin (Fig. 29).

In mature proglottides, uterus thick-walled sac, transversely elongate, situated just anterior to ovary; around it, modification of medullary parenchyma forms primordium of paruterine organ (Fig. 28). With further development, uterus expands in lateral direction, becoming arcuate (Fig. 30). In late post-mature proglottides, uterus assuming shape of horseshoe; paruterine organ surrounds entire uterus, its anterior part being thicker (Fig. 31). In gravid proglottides, uterus in general appearance horseshoe-shaped, lobate, entirely embedded by paruterine organ. Anterior part of paruterine organ fills entire median field (Fig. 33). Eggs with thin, irregular outer shell, situated closely to embryophore (Fig. 32). Embryophores thick-walled, spherical or slightly oval, with diameter 41-48 (44, n = 10). Oncospheres spherical, 28-32 (30, n = 10) in diameter. Embryonic hooks of central pair 20-22 long, with collar about their middle. Embryonic hooks of lateral pairs 17-19 long, with collar at about one third of their length.

REMARKS: This species was previously reported as *Paruterina* sp. collected from 1 of 17 specimens of the host species studied (Mariaux, 1994). The identification was based on its correspondence with the generic concept of *Paruterina* Fuhrmann, 1906 as presented by Matevosyan (1969) and Schmidt (1986). The current concept of *Paruterina* is restricted to a small group of species parasitising Strigiformes, while *Biuterina* includes species with two symmetrical uterine sacs connected by an anterior isthmus, no matter whether the entire uterus is embedded by the paruterine organ or only its anterior part (Bona & Maffi, 1984; Kornyushin, 1989; Georgiev & Kornyushin, 1994). Therefore, the morphology of the specimens studied corresponds to the diagnosis of *Biuterina* (see Georgiev & Kornyushin, 1994).

According to the structure of its uterus and paruterine organ, *B. pogoniuli* sp. n. corresponds to a group of species having a horseshoe-shaped uterus entirely embedded in the paruterine organ. This includes *B. cordifera*, a parasite of European and African insectivorous birds of the families Sylviidae and Turdidae (see above), and *B. chlorurae* (Rausch & Schiller, 1949), a parasite of North-American emberizid birds (Rausch & Schiller, 1949). The new species differs from *B. cordifera* by its considerably smaller rostellar hooks, greater number of testes and larger cirrus sac (Table 3). The ovary of *B. pogoniuli* is arcuate, while that of *B. cordifera* is more or less bi-winged (Georgiev *et al.*, 2004; present study). Other differences are related to the cirral armament (present in the new species and lacking in *B. cordifera*), the shape of the cirrus sac (elongate and oval, respectively) and the number of rostellar hooks (Table 3).

From *B. chlorurae*, the new species differs in its larger rostellar hooks, greater number of testes and larger cirrus sac (Table 3).

Other species possessing rostellar hooks of a similar size are *B. fuhrmanni* Schmelz, 1941 and *B. cylindrica* Fuhrmann, 1908. However, these two species possess a paruterine organ situated anterior to the uterus (Fuhrmann, 1908; Schmelz, 1941; Georgiev *et al.*, 2004).

Biuterina petroniae sp. n.

MATERIAL EXAMINED: MHNG INVE 16114, 49754 (formerly no 988.186, see Mariaux, 1994), 3 entire gravid specimens and 2 strobilar fragments stained and mounted in Canada balsam (2 slides) plus 2 scoleces mounted in Berlese's medium (2 slides); from *Petronia dentata*

(Sundevall) (Passeriformes: Ploceidae, Passerinae), collected on 19 February 1987 at Ouango-Fitini (9°37'N, 4°03'W). The host specimen has been deposited in the Ornithological Collection of the MHNG, no. 1773.018.

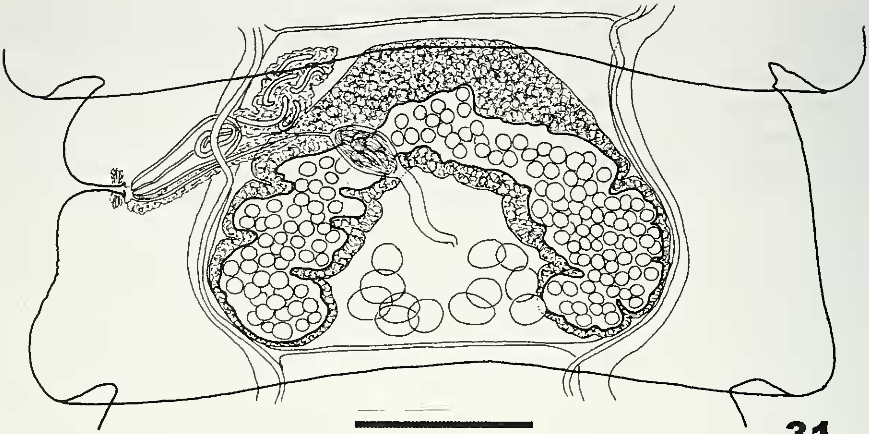
Holotype: MHNG INVE 16114, an entire specimen in Canada balsam, mounted on the same slide with 2 strobilar fragments.

Paratypes: MHNG INVE 49754, 2 entire specimens in Canada balsam; 2 scoleces in Berlese's medium; 2 fragments mounted on the same slide with the holotype.

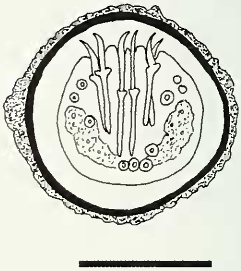
ETYMOLOGY: The species name *petroniae* is a derivate of the generic name of the host.

DESCRIPTION: Body gradually expands in posterior direction to level of pregravid proglottides and then with almost parallel lateral sides; gravid specimens 10.6-13.1 mm (11.7 mm, n = 3) in length, consisting of 51-56 (54, n = 3) proglottides (10-12 juvenile, 10-16 premature, 8-9 mature, 4-5 postmature, 13-15 pregravid and 2-3 gravid). Maximum width 0.63-0.70 mm (0.67 mm, n = 3) at pregravid proglottides. Scolex (Fig. 34) clearly outlined from neck by constriction, with maximum diameter 365-405 (680, n = 3) at level of posterior margin of sucker apertures; anterior part of scolex protruded, almost dome-shaped. Suckers situated on small but well-expressed pedicles (Fig. 34), cup-shaped, oval, 120-147 (131, n = 12) in diameter, with well-developed musculature. Rostellum sucker-like, cup-shaped, with diameter 90-112 (103, n = 3); numerous vertical muscular fibres and few glandular cells present within rostellum. Thick layer of radial musculature separate rostellum from surrounding tissue. Aggregations of glandular tissue present around rostellum. Rostellar armament consisting of 42-48, i.e. 42 (n = 2) or 48 (n = 2), rostellar hooks arranged in 2 regular rows. Each hook triangular, with epiphyseal thickening on both handle and guard; blades curved. Anterior and posterior hooks of different shape and size. Anterior hooks 38-40 (39, n = 12) long; blade slightly longer than handle (Fig. 35). Posterior hooks 28-30 (29, n = 11) long; blade and handle of almost equal length (Fig. 36). Neck 175 (n = l) wide in narrowest part (at constriction between it and scolex); first proglottides appear at 220-340 (n = 3) from posterior end of suckers. Proglottides craspedote; juvenile, premature, mature (Fig. 37), postmature and early pregravid (Fig. 39) proglottides wider than long; pregravid proglottides with more advanced development and gravid proglottides (Fig. 40, 41) almost as long as wide or slightly longer than wide. Genital pores alternating irregularly, predominantly in short series, e.g. ... 1, 2, 3, 2, 5, 1, 6, 1, 1, 1, 1, 1, 1, 5, 1; pores open slightly posterior to middle of lateral proglottis margin in mature proglottides (at border of anterior 38-45% of length of lateral proglottis margin) and at middle (48-55%) in gravid proglottides. Genital atrium 22-27 (24, n = 10) deep, thick-walled, with infundibular orifice and diameter of 10-14 (12, n = 10), provided with surrounding aggregation of intensely staining cells. No genital papilla. Dorsal osmoregulatory canals 4-6 (n = 10) in diameter, without transverse anastomoses. Ventral osmoregulatory canals 10-45 (n = 10) in diameter, with transverse anastomoses along posterior margin of each proglottis. Genital ducts pass between poral osmoregulatory canals.

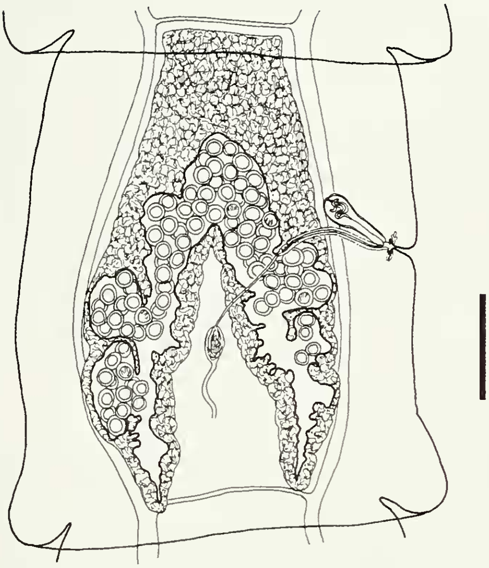
Testes 7-10 (8, n = 11) in number, round or slightly oval, form compact group situated entirely in median field, laterally and postero-dorsally to ovary and dorsally and laterally to vitellarium; diameter when fully developed 43-53 (49, n = 10). External vas deferens convoluted in anterior poral corner of median field, surrounded by pro-



31



32



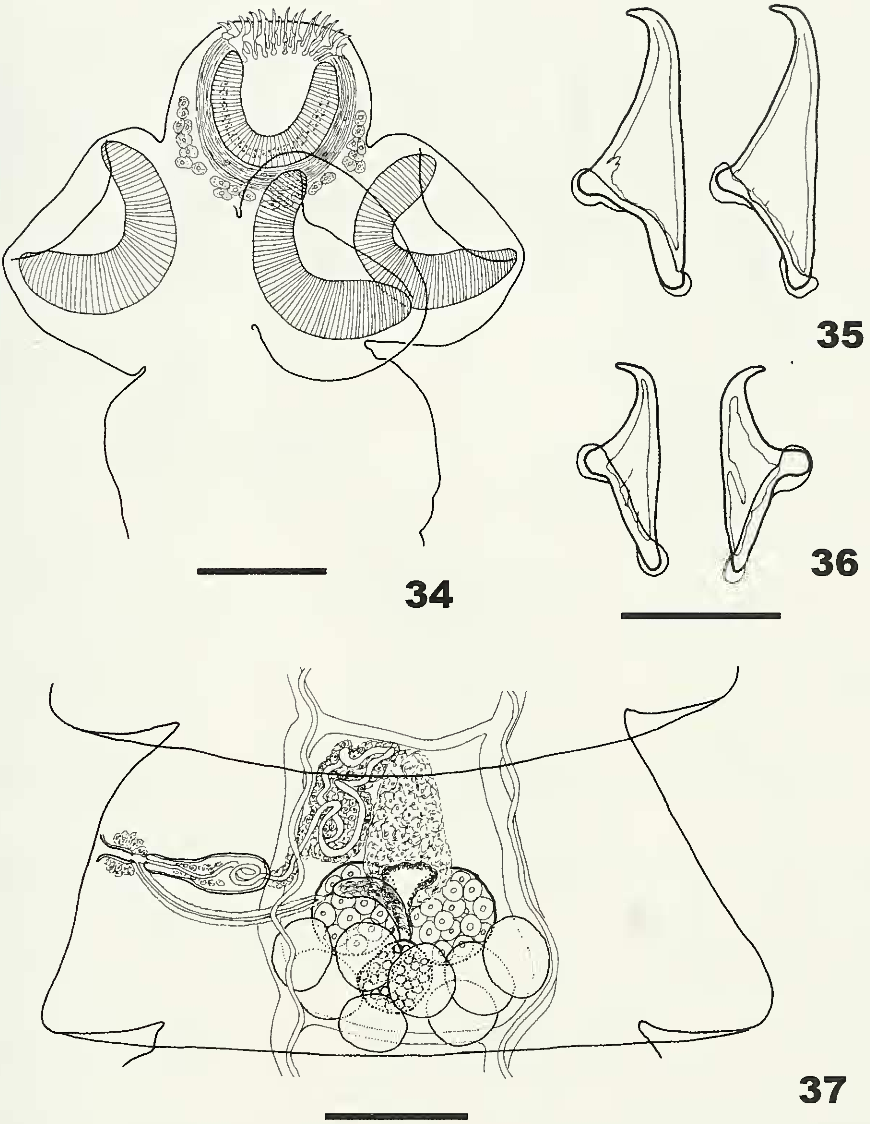
33

FIGS 31-33

Biuterina pogoniuli sp. n. (31) Late postmature proglottis, dorsal view. (32) Egg. (33) Gravid proglottis. Scale bars: 31, 33, 250 μm; 32, 50 μm.

static cells and together with them forming compact body; diameter of external vas deference 5-10 (8, n = 10). Cirrus-sac usually not reaching or only slightly overlapping poral osmoregulatory canals, 82-98 x 28-33 (92 x 31, n = 10), with rounded antiporal end and gradually tapering poral end; antiporal portion thick-walled; cirrus sac contains glandular cells surrounding canal of withdrawn cirrus and ejaculatory duct (Fig. 38). Internal vas deferens convoluted in antiporal part of cirrus-sac. No evaginated cirrus in material studied; no cirral armament observed in canal of withdrawn cirrus.

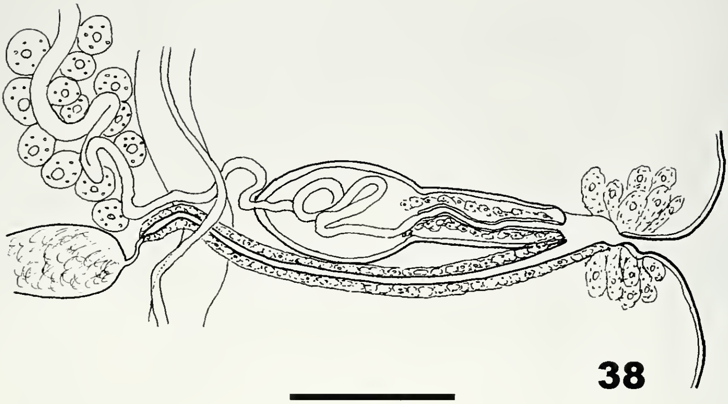
Ovary compact, bi-winged, occupies most of width of median field; wings rounded, connected by narrow isthmus (Fig. 37). Vitellarium median, oval or irregu-



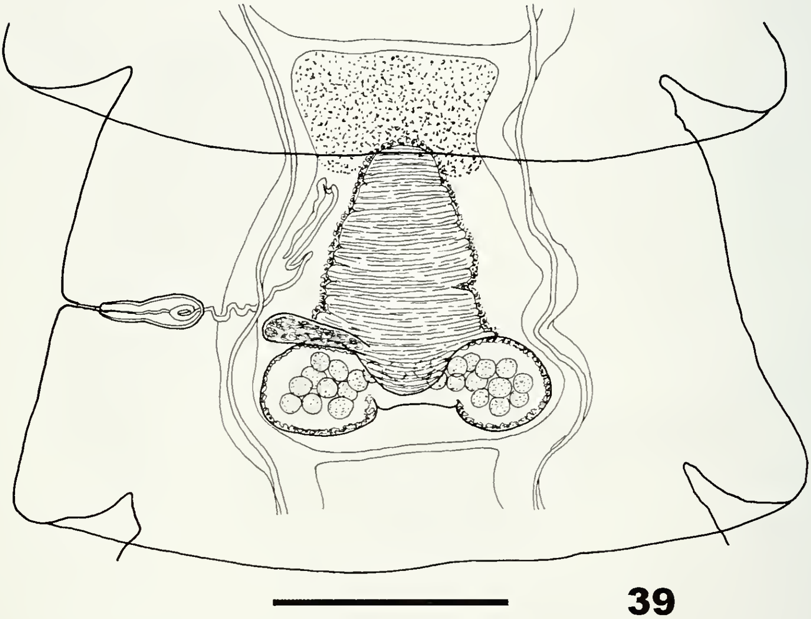
Figs 34-37

Biuterina petroniae sp. n. (34) Scolex. (35) Anterior rostellar hooks. (36) Posterior rostellar hooks. (37) Mature proglottis, dorsal view. Scale-bars: 34, 37, 100 Ìm; 35, 36, 20 μm.

larly suboval, slightly lobed or compact, 45-70 (57, n = 10) wide. Mehlis' gland globular, 18-24 (20, n = 10). Seminal receptacle dorsal to ovary and uterus, with rounded poral end with diameter 25-35 (31, n = 8) and antiporal end gradually forms wide seminal duct. Vagina opens posteriorly to male pore; copulatory part 137-162 (148, n = 8) long, consists of thin-walled vaginal canal with luminal diameter 6-10 (8,



38



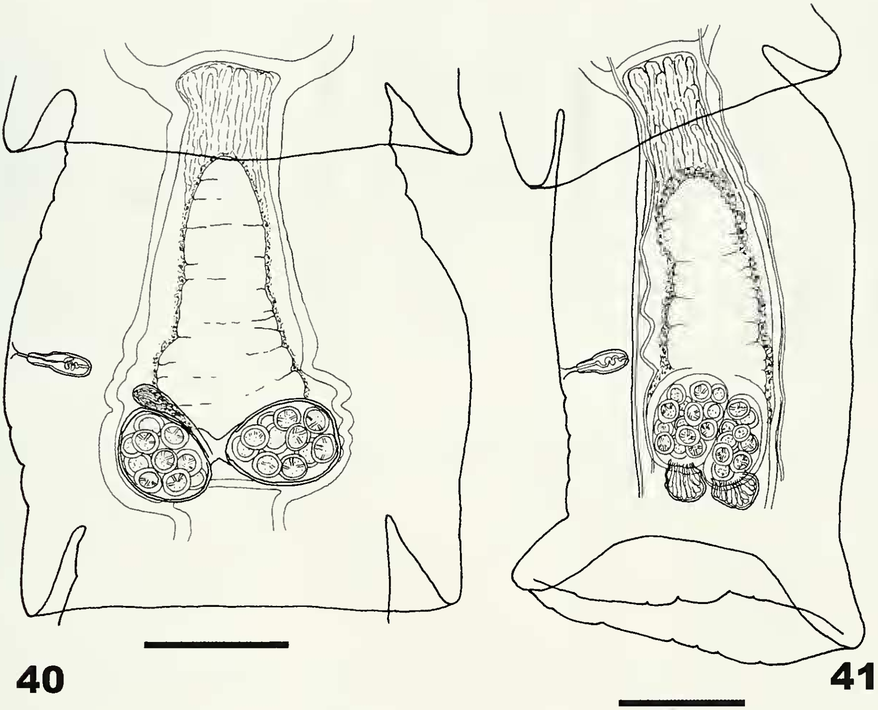
39

FIGS 38-39

Biuterina petroniae sp. n. (38) Genital ducts, dorsal view. (39) Pregravid proglottis, dorsal view. Scale bars: 38, 50 μm; 39, 200 μm.

n = 8) and thin, slightly expressed cellular sleeve; diameter of cellular sleeve 18-24 (21, n = 8); conductive part short, thin (Fig. 38).

In mature proglottides, uterus a thick-walled sac with irregular shape situated antero-dorsal to ovary; around and anteriorly to it, modification of medullary parenchyma forms primordium of paruterine organ (Fig. 37). With further development, uterus expands in lateral direction. In early pregravid proglottides (Fig. 39), uterus in form of single, transversely-elongate sac in most posterior part of median field; its



FIGS 40-41

Biuterina petroniae sp. n. (40, 41) Gravid proglottides showing the final stages of the development of the uterus and paruterine organ. Scale bars: 40-41, 200 μm.

lateral ends gradually differentiate as 2 distinct sacs divided by median constriction (Fig. 40). Paruterine organ consists of 2 parts; conical formation consisting predominantly of fibrilar tissue just anterior to uterine sac and modification of medullar parenchyma situated near anterior proglottis margin (Figs 39, 40); in addition, all medullary parenchyma are compacted. In most developed gravid proglottides available, eggs pass from uterine sacs into paruterine organ (Fig. 41). Eggs with thin, often indistinct, outer shell closely covering embryophore. Embryophore thick-walled, oval, with diameter 38-45 (42, n = 10). Oncosphere spherical, with diameter 27-34 (31, n = 10). Embryonic hooks of central pair 17-18 long, of lateral pairs 12-13 long; intralateral and extralateral embryonic hooks of the same shape.

REMARKS: The present material was reported as *Biuterina* sp. by Mariaux (1994). Judging by the size of the rostellar hooks, it is close to *B. macrancistrota* (Fuhrmann, 1908), *B. trapezoides* Fuhrmann, 1908, *B. campanulata* (Rudolphi, 1819) and *B. landsdowni* Malhotra & Capoor, 1987 (Table 3). The latter species, a parasite of *Upupa epops* L. in India (Malhotra & Capoor, 1987), is the only member of the genus for which the posterior hooks are reported to be longer than anterior hooks. The structure of its uterus and paruterine organ and the shape of the rostellar hooks, as illustrated by Malhotra & Capoor (1987), very much resemble those of *Neyraia* Joyeux

TABLE 3. Some characteristics of the species currently placed in *Biuterina* Fuhrmann, 1902 (ordered by decreasing length of the anterior rostellar hooks).

Species	Hosts	Distribution (faunal realms)	Rostellar hooks			Testes: number	Cirrus sac: measurements	Source
			Number	Length				
				Anterior	Posterior			
B. africana Joyeux & Baer, 1928, syn. *B. pentamyzos* (Mettrick, 1960) Matevosyan, 1964,	Laniidae	Afrotropical	38-44	75-85	55-63	10-15	163-232x27-40	Georgiev *et al.* (2002), present study
B. cordifera Murai & Sulgostowska, 1983	Sylviidae, Turdidae	Palaearctic, Afrotropical.	26-30	56-71	43-51	7-11	52-105x21-42	Georgiev *et al.* (2004), present study
B. morgani (Rausch & Schiller, 1949) Matevosyan, 1965	Troglodytidae	Nearctic	34-36	66	40	15-18	86-105x16-20	Matevosyan (1969)
B. triangula (Krabbe, 1869) Fuhrmann, 1908	Turdidae, Motacillidae	Palaearctic, Afrotropical	40-44	58-65	37-43	6-9	120-155x30-40	Kornyushin (1989), present study
B. erithaci Ryšavý & Sixl, 1977	Turdidae	Palaearctic	14	56-60	48	12-16	~140x-[6]	Ryšavy (1977)
B. planirostris (Krabbe, 1882) Fuhrmann, 1908	Alaudidae	Palaearctic	40	49	27	-	-	Fuhrmann (1908)
B. sobolevi Sudarikov, 1950	Turdidae	Palaearctic	42	48	33	8-10	111-114x-	Sudarikov (1950)
B. fallax Meggitt, 1928	Meropidae	Palaearctic	18-20	44-48[1]	44-48[1]	12	90x26	Meggitt (1928)
B. diversihamata Sawada, Hassan & Saleen, 1994	Coraciidae	Palaearctic	36-38	46	39	9-10	98-105x28-35	Sawada *et al.* (1994)
B. campanulata (Rudolphi, 1819) Fuhrmann, 1908	Tyrannidae, Formicariidae	Neotropical	26	43-46	32-36	8-10	-	Fuhrmann (1908)
B. macrancistrota (Fuhrmann, 1908) Mariaux & Vaucher, 1989, Syn. *B. meropina* var. *macrancistrota* Fuhrmann, 1908	Meropidae	Afrotropical	43-49	38-44	28-34	8-11	89-113x34-40	Mariaux & Vaucher (1989)
B. trapezoides Fuhrmann, 1908	Icteridae, Emberizidae (?), Caprimulgidae (?)	Neotropical	~30	41	34	-	-	Fuhrmann (1908)
B. lansdowni Malhotra & Capoor, 1987	Upupidae	Oriental	34-50	39-40	43-45	17-37	104-143x24-46	Malhotra & Capoor (1987)
B. petroniae sp. n.	Ploceidae	Afrotropical	42-48	38-40	28-30	7-10	82-98x28-33	Present study
B. reynoldsi (Daly, 1958) Matevosyan, 1964	Corvidae	Nearctic	44-48	33	21	12-14	-	Daly (1958)
B. passerina Fuhrmann, 1908	Alaudidae	Palaearctic	-	25-28[1]	25-28[1]	11-14	75-86x25-30	Fuhrmann (1908), Georgiev *et al.* (2004)
B. meropina (Krabbe, 1869) Fuhrmann, 1908	Meropidae	Palaearctic	40	27	22	-	-	Krabbe (1869)

B. distincta Fuhrmann, 1908	Icteridae (?)[2]	Neotropical	~20	25[1]	25[1]	12	140x-	Fuhrmann (1908)
B. pogoniuli sp. n.	Capitonidae	Afrotropical	56-62	24-25	22-25	12-17	165-192x49-63	Present study
B. cylindrica Fuhrmann, 1908	Thraupidae	Neotropical	52	23-25[1]	23-25[1]	~8	80?-	Fuhrmann (1908)
B. fuhrmanni Schmelz, 1941, syn. *B. clerci* Spasskii, 1946[4]	Emberizidae	Palaearctic	(42?) 48-52	20-25	17-21	12-17	89-120x39-54	Georgiev *et al.* (2004)
B. zambiensis (Mettrick, 1960) Matevosyan, 1964	Campephagidae	Afrotropical	48	19-22	16-18	7-10	70-77x23-31	Georgiev *et al.* (2002)
B. trigonacantha Fuhrmann, 1908	Furnariidae	Neotropical	~60	20-22[1]	20-22[1]	10	-	Fuhrmann (1908)
B. quelea (Mettrick, 1963) Spasskii, 1977	Ploceidae	Afrotropical	56-58	19-21	16-18	9-13	93-143x36-49	Georgiev *et al.* (2002)
B. ugandae Baylis, 1919	Nectariniidae	Afrotropical	58	20-21	17-19	12-14	82-90x34-41	Georgiev *et al.* (2002)
B. singhi Matevosyan, 1965, syn *B. meggitti* Singh, 1959, pre-occupied	Dicruridae	Oriental	56	17-21	13-16	9-12	80-120x27-38	Singh (1959)
B. chlorurae (Rausch & Schiller, 1949) Spasskaya & Spasskii, 1971	Emberizidae	Nearctic	40-42	20	16	10-12	105-119x23-29	Matevosyan (1969)
B. collurionis Matevosyan, 1950	Laniidae	Palaearctic	58-64	18-20	15-17	10-12	80-110x30-38	Matevosyan (1969), Kornyushin (1989)
B. dicruri Singh, 1964	Dicruridae	Oriental	40	18	14-16	7-11	80-110x26-40	Matevosyan (1969)
B. motacillabrasiliensis (Rudolphi, 1819) Fuhrmann, 1932	Motacillidae (?)[3]	Neotropical	30	15[1]	15[1]	-	-	Krabbe (1869)
B. globosa Fuhrmann, 1908	Cotingidae	Neotropical	24	14-16[1]	14-16[1]	-	-	Fuhrmann (1908)
B. motacillacayanae (Rudolphi, 1819) Matevosyan, 1969, syn. *B. motacilla* Fuhrmann, 1908	Thraupidae	Neotropical	32	14[1]	14[1]	-	-	Fuhrmann (1908)
B. clavula (von Linstow, 1888) Fuhrmann, 1908, syn. *B. paradisea* Fuhrmann, 1902[5]	Paradisaeidae	Australian	56-60	11-12[1]	11-12[1]	32	-	Fuhrmann (1908)
B. mertoni Fuhrmann, 1911	Paradisaeidae	Australian	-	-	-	~15	-	Fuhrmann (1911)

[1] Lengths of the anterior and posterior hooks not given separately.

[2] Originally described from '*Gracula* sp.' (Fuhrmann, 1908). The genus *Gracula* L. belongs to the family Sturnidae, which does not occur in South America (Howard & Moore,1980). The material originated from Vienna Museum and several icterid genera occurring in Brazil have as part of their German vernacular name 'Grackel'. In English, 'grackle' is used as a part of the vernacular name of both *Gracula* spp. and several icterid genera.

[3] Originally described from '*Motacilla* sp.' from Brazil (Krabbe, 1869). The genus *Motacilla* L. does not occur in South America (Howard & Moore, 1980).

[4] Synonymy after Georgiev *et al.* (2004).

[5] Synonymy after Fuhrmann (1908).

[6] Rysavy & Sixl (1977) did not report the length of the cirrus sac; the length given in the table is estimated on the basis of their drawing of mature proglottis.

& Timon-David, 1934 (see Georgiev & Kornyushin, 1994), a genus which includes specific parasites of hoopoes (Upupidae and Phoeniculidae); therefore, we believe that the affiliation of this species to *Biuterina* requires further confirmation. Nevertheless, *B. petroniae* differs from *B. landsdowni* by the considerably smaller number of testes and a substantial difference in the length of the posterior rostellar hooks (Table 3).

B. campanulata and *B. trapezoides* are poorly known Neotropical species; the only sources concerning their morphology are their original descriptions (Fuhrmann, 1908). They are both characterised by a considerably smaller number of rostellar hooks (26 and about 30, respectively) than in the present material (42-48).

Our worms are most similar to *B. macrancistrota* (for a redescription, see Mariaux & Vaucher, 1989). This species has a body about twice the length of our material (22 versus 10-13 mm) and consists of many more proglottides (180 versus 51-56). A substantial part of its cirrus sac is situated in the median field in mature proglottides, while in the new species this organ occurs in the lateral field. Another difference is the shape of ovary, which is clearly bi-winged in the new species and a massive, rather transversely elongate oval structure in *B. macrancistrota*.

On the basis of these differences, we consider that the present material is a new species.

DISCUSSION

In addition to the material described above, Mariaux (1994) reported a species of *Biuterina* from *Sylvietta virens* Cassin (Sylviidae). This material does indeed belong to this genus and might represent a new species. However, the specimens available are fragmented and do not permit the preparation of a complete description.

The concept of *Biuterina* adopted in the present article corresponds to those presented in previous studies (Bona & Maffi, 1984; Kornyushin, 1989; Georgiev & Kornyushin, 1994). It is defined by the presence of two symmetrical uterine sacs connected by an anterior isthmus, no matter whether the entire uterus is embedded by the paruterine organ or only its anterior part. However, whether this is a synapomorphy of a monophyletic *Biuterina* or not will be a subject for further studies. Furthermore, other paruterinid genera (*Triaenorhina* Spasskii & Shumilo, 1965, *Neyraia* Joyeux & Timon-David, 1934 and *Spasskyterina* Kornyushin, 1989) are characterised by two symmetrical uterine sacs, although of various shape.

Currently, we recognise 34 species as belonging to this genus (Table 3). The position of two of them in *Biuterina* is doubtful. *B. lansdowni* Malhotra & Capoor, 1987, from *Upupa epops* L. in India (Malhotra & Capoor, 1987), has hooks and gravid proglottides strongly resembling *Neyraia intricata* (Krabbe, 1878) from the same host species. Whereas *B. diversihamata* Sawada, Hassan & Saleen, 1994, from *Coracias garrulus* L. in Iraq (Sawada *et al.*, 1994), we suspect to be a synonym of *Triaenorhina rectangula* (Fuhrmann, 1908). It is our opinion that these two taxa represent *species inquirendae*, but they are retained in the key below, pending a re-examination of the type material.

Six species have previously been considered members of *Biuterina* (see Matevosyan, 1969; Schmidt, 1986) and are currently placed in other genera. *B. rectangula* Fuhrmann, 1908 from *Coracias garrulus* L. (Europe?) was selected as the type species of *Triaenorhina* (see Spasskii & Shumilo, 1965). Three cestode species from the same host were recognised as synonyms of *T. rectangula*; these are *B. coracii* Chiriac, 1963 from Romania, *B. garrulae* (Matevosyan, 1950) from Smolenskaya Oblast', Russia, and *B. uzbekiensis* Matevosyan, 1964 from Uzbekistan (synonymy after Spasskaya & Spasskii, 1971; Kornyushin, 1989; Georgiev & Gibson, 2006). In addition, *B. dunganica* Skrjabin, 1914 from *Oriolus oriolus* L. in Kazakhstan was transferred to *Spasskyterina* Kornyushin, 1989 (see Kornyushin, 1989) and *B. meggitti* (Johri, 1931) from bucerotid birds in India and Somalia is currently recognised as a species of *Triaenorhina* (see Kornyushin, 1989; Georgiev & Gibson, 2006).

Recent studies have provided new morphological data for most of the Old-World species and re-evaluated their validity (Kornyushin, 1989; Mariaux & Vaucher, 1989; Georgiev *et al.*, 2002, 2004). However, most of the New-World species are known from their original descriptions only and are in need of taxonomic revision. Nevertheless, we propose the following key based on our current knowledge of *Biuterina* spp. (*B. motacillabrasiliensis* and *B. motacillacayanae* are poorly described parasites of Neotropical passerines and lack reliable distinguishing features.

KEY TO THE SPECIES OF *BIUTERINA*

(See Table 3 for authorities for species names)

1a. Parasites of Paradisaeidae in the Australian Region 2
1b. Parasites of other birds 3
2a. Testes ~30 in number. Genital atrium without distinct dilatory muscles . . . . *B. clavula*
2b. Testes ~15 in number. Genital atrium with distinct dilatory muscles . . . . *B. mertoni*
3a. Anterior rostellar hooks ≤ 17 long; if anterior rostellar hooks 17 long then total number of rostellar hooks ≤ 32 4
3b. Anterior rostellar hooks □17 long; if anterior rostellar hooks 17 long or slightly longer then total number of rostellar hooks □40 5
4a. Rostellar hooks 24 in number . . . . *B. globosa*
4b. Rostellar hooks 30-32 in number . . . . *B. motacillabrasiliensis* and *B. motacillacayanae*
5a. Uterus entirely embedded in paruterine organ in pregravid proglottides 6
5b. Paruterine organ situated anterior to uterus in pregravid proglottides, not entirely embedding it 8
6a. Developing uterus horseshoe-shaped, with posteriorly directed lateral extremities 7
6b. Developing uterus consisting of two rounded lateral chambers connected anteriorly by narrow, branched isthmus . . . . *B. passerina*
7a. Rostellar hooks 26-30 in number; anterior hooks □56 long . . . . . . *B. cordifera*
7b. Rostellar hooks 56-62 in number; anterior hooks 24-25 long . . . . *B. pogoniuli*
7c. Rostellar hooks 40-42 in number; anterior hooks 20 long . . . . *B. chlorurae*
8a. Anterior rostellar hooks > 35 long 9
8b. Anterior rostellar hooks < 35 long 21

9a. Number of rostellar hooks ≤ 20 10
9b. Number of rostellar hooks □26 11
10a. Number of rostellar hooks 14; anterior rostellar hooks 56-60 long; cirrus sac ~140 long .... *B. erithaci*
10b. Number of rostellar hooks 18-20; anterior rostellar hooks 44-48 long; cirrus sac ~90 long .... *B. fallax*
11a. Anterior rostellar hooks 75-85 long .... *B. africana*
11b. Anterior rostellar hooks ≤ 70 long 12
12a. Anterior rostellar hooks 58-66 long 13
12b. Anterior rostellar hooks 38-49 long 14
13a. Rostellar hooks 34-36 in number; testes 15-18 in number; cirrus sac 86-105 long .... *B. morgani*
13b. Rostellar hooks 40-44 in number; testes 6-9 in number; cirrus sac > 120 long .... *B. triangula*
14a. Rostellar hooks spine-like .... *B. lansdowni*
14b. Rostellar hooks triangular, of typical shape for *Biuterina* 15
15a. Rostellar hooks ≤ 30 in number 16
15b. Rostellar hooks > 35 in number 17
16a. Rostellar hooks 26 in number, anterior rostellar hooks 43-46 long; paruterine organ wide, occupying almost entire width of median field .... *B. campanulata*
16b. Rostellar hooks ~30 in number; anterior rostellar hooks 41 long; paruterine organ in middle of median field .... *B. trapezoides*
17a. Anterior rostellar hooks < 45 long 18
17b. Anterior rostellar hooks > 45 long 19
18a. Gravid strobila consisting of ~180 proglottides; cirrus sac crosses poral osmoregulatory canals and substantial part of it situated in median field .... *B. macrancistrota*
18b. Gravid strobila consisting of ~50-60 proglottides; cirrus sac in lateral field .... *B. petroniae*
19a. Posterior rostellar hooks not longer than 55% of length of anterior rostellar hooks .... *B. planirostris*
19b. Posterior rostellar hooks longer than 60% of length of anterior rostellar hooks 20
20a. Blade of rostellar hooks 4-5 times shorter than handle .... *B. diversihamata*
20b. Blade of rostellar hooks slightly longer than handle or of same length .... *B. sobolevi*
21a. Rostellar hooks ~20 in number .... *B. distincta*
21b. Rostellar hooks > 30 in number 22
22a. Anterior rostellar hooks > 30 long .... *B. reynoldsi*
22b. Anterior rostellar hooks < 30 long 23
23a. Rostellar hooks > 56 in number 24
23b. Rostellar hooks ≤ 52 in number 27
24a. Rostellum consists of weak musculature and strongly developed glandular tissue .... *B. quelea*

24b. Rostellum consists of strongly developed musculature, with no glandular tissue or glandular tissue weakly developed 25
25a. Paruterine organ in pregravid proglottides occupies entire width of median field . . . . *B. ugandae*
25b. Paruterine organ distinctly narrower than width of median field 26
26a. Parasite of Furnariidae in the Neotropics (Brazil) . . . . *B. trigonacantha*
26b. Parasite of Dicruridae in India . . . . *B. singhi*
26c. Parasite of Laniidae in the Palaearctic . . . . *B. collurionis*
27a. Rostellar hooks 40 in number 28
27b. Rostellar hooks □48 (possibly, as exception, 42 in *B. fuhrmanni*) 29
28a. Anterior rostellar hooks 27 long . . . . *B. meropina*
28b. Anterior rostellar hooks < 20 long . . . . *B. dicruri*
29a. Testes number □12 . . . . *B. fuhrmanni*
29b. Testes number ≤ 10 30
30a. Rostellar hooks 52 in number; anterior rostellar hooks 23-25 long . . . . *B. cylindrica*
30b. Rostellar hooks 48 in number; anterior rostellar hooks 19-22 long . . . . *B. zambiensis*

ACKNOWLEDGEMENTS

We are grateful to Dr D.I. Gibson (London) for reading the manuscript. The Natural History Museum, Geneva, funded research visits of the senior author, enabling joint studies.

REFERENCES

Bona, F. V. & Maffi, A. V. 1984. La estructura del género *Paruterina* Fuhrm., 1906 y consideraciones los géneros *Biuterina* Fuhrm., 1902, *Proparuterina* Fuhrm., 1911 y *Sphaeruterina* Johnston, 1914 (Cestoda, Paruterinidae). *Bollettino del Museo Regionale di Scienze Naturali – Torino* 2: 411-443.

Daly, E. F. 1958. A new dilepidid cestode, *Paruterina reynoldsi*, from the southern crow, *Corvus brachyrhynchos paulus* Howell. *Proceedings of the Helminthological Society of Washington* 25: 34-36.

Fuhrmann, O. 1908. Das Genus *Anonchotaenia* und *Biuterina*. II. Das Genus *Biuterina* Fuhrmann. *Centralblatt für Bakteriologie, Parasitenkunde und Infektionskrankheiten, Erste Abteilung – Originale* 48: 412-428.

Fuhrmann, O. 1911. Vogelcestoden der Aru-Inseln. *Abhandlungen der Senckenbergischen Naturforschenden Gesellschaft* 34: 251-266.

Fuhrmann, O. 1943. Cestodes d'Angola. *Revue suisse de Zoologie* 50: 449-472.

Georgiev, B. B. & Gibson, D. I. 2006. Description of *Triaenorhina burti* n. sp. (Cestoda: Paruterinidae) from the Malabar trogon *Harpactes fasciatus* (Pennant) (Aves: Trogoniformes: Trogonidae) in Sri Lanka. *Systematic Parasitology* 63: 53-60.

Georgiev, B. B. & Kornyushin, V. V. 1994. Family Paruterinidae Fuhrmann, 1907 (*sensu lato*). (pp. 559-584). *In*: Khalil, L. F., Jones, A. & Bray, R. A. (eds). Keys to the cestode parasites of vertebrates. *CAB International, Wallingford, UK.*

Georgiev, B. B. & Vaucher, C. 2001. Revision of the genus *Parvirostrum* Fuhrmann, 1908 (Cestoda, Cyclophyllidea, Paruterinidae). *Systematic Parasitology* 50: 13-29.

Georgiev, B. B., Vasileva, G. P., Bray, R. A. & Gibson, D. I. 2002. The genus *Biuterina* Fuhrmann, 1902 (Cestoda, Paruterinidae) in the Old World: redescriptions of four species from Afrotropical Passeriformes. *Systematic Parasitology* 52: 111-128.

GEORGIEV, B. B., VASILEVA, G. P., BRAY, R. A. & GIBSON, D. I. 2004. The genus *Biuterina* Fuhrmann, 1902 (Cestoda, Paruterinidae) in the Old World: redescriptions of three species from Palaearctic Passeriformes. *Systematic Parasitology* 57: 67-85.

HOWARD, R. & MOORE, A. 1980. A complete checklist of the birds of the world. *Oxford University Press, Oxford*, 701 pp.

JOYEUX, C. & BAER, J.-G. 1928. Cestodes. (pp. 17-54). *In*: JOYEUX, C., GENDRE, E., & BAER, J.-G. (eds). Recherches sur les helminthes de l'Afrique occidentale française. (Collection de la Société de Pathologie Exotique, Monographie II.), *Masson et C^{ie}, Paris.*

KORNYUSHIN, V. V. 1989. [Fauna of Ukraine. Volume 33. Monogenea and Cestoda. Part 3. Davaineoidea. Biuterinoidea. Paruterinoidea.] *Naukova Dumka, Kiev,* 252 pp. (In Russian).

KRABBE, H. 1869. Bidrag til Kundskab om Fuglenes Baendelorme. *Videnskabelige Selskab Skrifter, 5. Raekke, Naturvidenskabelig og Mathematisk Afdel* 8: 251-389.

MALHOTRA, S. K. & CAPOOR, V. N. 1987. Avian cestodes of the Himalayan ecosystems. II. *Biuterina lansdowni* sp. n. from *Upupa epops*. *Helminthologia* 24: 15-21.

MARIAUX, J. 1994. Avian cestodes of the Ivory Coast. *Journal of the Helminthological Society of Washington* 61: 50-56.

MARIAUX, J. & VAUCHER, C. 1989. Cestodes d'oiseaux de Côte d'Ivoire. II. Parasites de Coraciiformes et Piciformes. *Systematic Parasitology* 14: 117-133.

MATEVOSYAN, E. M. 1969. [Paruterinoidea - tapeworms of domestic and wild birds.] *In*: SKRYABIN, K.I. (ed.) Osnovy Tsestodologii. *Izdatel'stvo 'Nauka', Moscow,* VII, 304 pp. (In Russian).

MEGGITT, F. J. 1928. Report on a collection of Cestoda, mainly from Egypt. Part III. Cyclophyllidea (Conclusion): Tetraphyllidea. *Parasitology* 20: 315-328.

METTRICK, D. F. 1960. Two new species of the genus *Paruterina* Fuhrmann, 1906, from passeriform birds in Southern Rhodesia. *Proceeding of the Helminthological Society of Washington* 27: 181-184.

MURAI, E. & SULGOSTOWSKA, T. 1983. *Biuterina cordifera* sp. n. (Cestoda: Paruterinoidea) from Sylviinae (Aves: Passeriformes) in Hungary. *Parasitologia Hungarica* 16: 93-100.

RAUSCH, R. & SCHILLER, E. 1949. A contribution to the study of North American cestodes of the genus *Paruterina* Fuhrmann, 1906. *Zoologica* 34: 5-8.

RYŠAVÝ, B. & SIXL, W. 1977. Zur Kenntnis der Vogelcestoden in der Steiermark (mit Beschreibung von zwei neuen Arten). *Mitteilungen der Abteilung für Zoologie am Landesmuseum Joanneum* 6: 41-50.

SATTMAN, H. 2000. Profile: Johann Gottfried Bremser (1767-1827). *Systematic Parasitology* 47: 231-232.

SAWADA, I., HASSAN, I. S., SALEEN, K. M. 1994. On cestodes parasites of Iraqi birds. *Bulletin of the Biogeographical Society of Japan* 49: 93-97.

SCHMELZ, O. 1941. Quelques Cestodes nouveaux d'Oiseaux d'Asie. *Revue suisse de Zoologie* 48: 143-199.

SCHMIDT, G. D. 1986. CRC handbook of tapeworm identification. *CRC Press, Boca Raton, Florida*, 675 pp.

SINGH, K. P. 1959. Some avian cestodes from India. I. Species belonging to families Davaineidae and Biuterinidae. *Indian Journal of Helminthology* 11: 1-24.

SPASSKAYA, L. P. & SPASSKII, A. A. 1971. [Cestodes of birds in Tuva.] *Shtiintsa, Kishinev*, 252 pp. (In Russian).

SPASSKII, A. A. & SHUMILO, R. P. 1965. [The phenomenon of the postlarval development of the rostellum and the hooks in the cestodes of the genus *Triaenorhina*, n. gen. (Paruterinidae).] *Doklady Akademii Nauk SSSR* 164: 1436-1438. (In Russian).

SUDARIKOV, V. E. 1950. [New cestode species from the basin of Middle Volga.] *Trudy Gel'mintologicheskoy Laboratorii Akademii Nauk SSSR* 3: 142-151. (In Russian).